SCIENCE ABSTRACTS.

Section A.—PHYSICS.

MARCH, 1927.

GENERAL PHYSICS.

521. *The Last Fifteen Years of Physics.* **R. A. Millikan.** (Am. Phil. Soc., Proc. 65. 2. pp. 68–78, 1926.)—A review.

522. *Gas Density Determinations with the Displacement Balance. Part II. Ethylene as Comparison Gas.* **A. Stock** and **G. Ritter.** (Zeits. phys. Chem. 124. pp. 204–216, Nov. 28, 1926.)—Measurements of gas densities by means of the balance described earlier [see Abstract 1488 (1926)] are now recorded. Accuracy is found to depend on the exact measurement of the pressure and on the comparison gas. The latter must be absolutely pure and have a density not differing much from that of the gas compared, also its deviations from the perfect gas laws must be accurately known. Air is entirely unsuitable, oxygen not good practically, and ethane insufficiently pure. The authors have found ethylene to answer their purpose exceedingly well, and the paper includes a method for its preparation with the physical data and mode of determination. Oxygen is then compared with ethylene and its mode of preparation, etc., similarly described. The entire paper is a detailed description of the precautions taken to ensure absolute accuracy with the particular type of balance employed. H. H. Ho.

523. *Realisation of a Damped Zenithal Gyrostatic Compass.* **H. Beghin** and **P. Monfraix.** (Comptes Rendus, 183. pp. 856–858, Nov. 15, 1926.)—A zenithal compass, designed by the author to preserve the vertical aboard a ship or an aircraft in motion, consists, in principle, of a gyro-pendulum which, to be insensitive to rolling and pitching, must have a long period, *e.g.*, about ten minutes. Too long a period reduces the accuracy of the equilibrium position, and, in addition, increases the correction due to terrestrial rotation and vessel speed. The gyrostat is operated electrically, being the rotor of an asynchronous motor which makes 20,000 r.p.m. Constructional details are included, and it is claimed that the equilibrium position is always attained within three minutes.

H. H. Ho.

524. *New Procedures in High Vacua Technology.* **Marie Anna Schirmann.** (Phys. Zeits. 27. pp. 659–680, Nov. 1, 1926.)—In sealing off evacuated vessels difficulties always result, since gas is disengaged when the glass at the seal is melted prior to sealing off. The author considers the flow of gas, in terms of the Knudsen law of the molecular flow of gases, forwards to the pumping system and backwards to the evacuated vessel. It is so shown if the seal is not made near the evacuated vessel, as is usual, but distant to this along a capillary tube there is a large resistance to the flow of the disengaged gases back to the vessel, and these are therefore pumped off more easily before closing the seal. The original low pressure of the vessel is so maintained in spite of the gas disengagement during the process of sealing off. A sealing-off technique is evolved, and its application to high vacua technical processes, as thermionic valve manufacture, is discussed.

In the second part of the paper an "electrically sealed" high vacuum stop-cock is described, which obviates the need of mercury or oil seals and lubrication, with attendant practical disadvantages. In this type of cock the rotating portion is made of metal. This rotates in the normal glass sleeve, or a sleeve of other insulating material, surrounding which is an external metallic electrode. A potential is applied between this electrode and the rotating portion. This potential prevents the passage of gas between the rotating and fixed portions of the cock and so prevents leakage and loss of vacuum. The actual phenomenon which prevents this gas flow is considered and appears to be based upon the Johnsen-Rahbek effect. The applications of this principle to cocks for various purposes in high vacua technology are illustrated. B. J. L.

525. *The Production of the Highest Vacua by Means of Cooling Metals Used as Sorbents.* **Marie Anna Schirmann.** (Phys. Zeits. 27. pp. 748–751. Nov. 15, 1926. Paper read before the Deut. Naturforscher u. Ärzte, Düsseldorf, 1926.)—The author has found that specially activated tungsten filaments are very effective as "sorbents" of the residual gases in an evacuated vessel. The process of sorption may include adsorption and absorption. The filaments are prepared by the sintering process in such a way that they consist of very minute crystallites which are not really consolidated into a solid mass, but are full of minute pores and cracks, so that the total metallic surface is very large; a special heat treatment during the sintering is necessary for this. The metal thus obtains properties similar to those of platinum black and palladium sponge, since hard metals are the best adsorbers of gases. In using these filaments to obtain a very high vacuum the occluded gas is driven out of them by repeated slow heating to a high temperature with pauses by means of an electric current, followed by slow cooling; in this way the vaporisation of the tungsten is kept to a minimum and its porous structure is retained. An experiment is described in which the glass container was first freed from the gases held in the walls by discharges produced by means of external electrodes. The tungsten filament was then slowly and repeatedly heated and cooled, the pressure at the start was 10^{-8} mm. Hg, while the filament was hot it was from 10^{-4} to 10^{-5} mm., and at the end of successive cooling pauses 10^{-8}, 10^{-9} and finally 10^{-10} mm. H. N. A.

526. *Effect of Temperature on the Viscosity of the Air.* **F. A. Williams.** (Roy. Soc., Proc. 113. pp. 233–237, Nov. 1, 1926.)—Rankine's criticisms [Abstract 1984 (1926)] of the author's work [Abstract 1193 (1926)] are shown to be invalid. T. H. P.

527. *Flow of Liquids through Capillaries.* **N. E. Dorsey.** (Phys. Rev. 28. pp. 833–845, Oct., 1926.)—A simple theory of the flow of a liquid from a reservoir, through a capillary, into a second reservoir is developed, and the conclusions from it are shown to accord with the observations of Bond and of Poiseuille, and with a qualitative study of the flow by means of coloured streams. It is shown that, for viscosimeters of this type, the common interpretation of that term (with coefficient *m*) in the viscosimeter equation which is frequently called the kinetic energy correction is entirely incorrect. That term is an inertia correction; it does nor arise from any loss of head attendant upon the imparting of kinetic energy to the liquid, but solely from a progressive change in the distribution of the flow in the exit reservoir. It is not the correction which was considered by Hagenbach. For ideal conditions, *m* is probably equal to unity. At very low velocities, the distribution of the flow in each reservoir is independent of the velocity, and consequently the inertia term vanishes; at this stage the Couette correction is $2e$, twice what it is when the distribution in the exit reservoir is changing. From Bond's data, it is found that $e = 0{\cdot}573r$. At a certain velocity, simply related to *e*, the distribution of the flow in the exit reservoir begins to change, the inertia term appears. Bond found that this occurs when the Reynolds number is 10. Under certain stated conditions, the initial distribution of flow can be retained to a much higher velocity; in these cases the inertia correction does not enter, and *pt* is independent of the velocity. There are indications that for very short tubes *pt* ceases to be linear in the velocity before the flow in the tube becomes turbulent. An explanation is offered. Changes in the terminal configurations affect both the Couette correction and the inertia correction, and the second may be markedly affected by changes in the size and form of the exit reservoir. As commonly used, the subdivided tube method for determining *e* is entirely unreliable. AUTHOR.

528. *Properties of Thin Films.* **W. B. Hardy.** (Nature, 118. pp. 700–701, Nov. 13, 1926. Paper read before the Roy. Inst., Jan. 29, 1926.)—The author mentions generally the effect of films on surfaces of porcelain and china and of oil on water. He considers the lowered surface tension and increased mechanical stability are not the causes of the calming of the sea by oil because the surface of the sea is always contaminated in some way. This contamination produces a lower surface tension and increases stability as is shown by the formation of foam. In the absence of oil a great wave carries countless ripples and wavelets, each of which gives the wind a direct thrust on the surface. When these cease to be formed the chief " catch " of the wind upon the sea is lost, and it is in this way that the oil film calms the sea. R. S. R.

529. *Surface Tension of Liquid Neon.* **A. T. van Urk, W. H. Keesom** and **G. P. Nijhoff.** (K. Akad, Amsterdam, Proc. 29. 7. pp. 914–916, 1926.)—The surface tension of liquid neon was determined by the same method as that used for the measurement of the surface tension of liquid helium [see Abstract 1979 (1926)]. The neon was purified by freezing it in liquid hydrogen and the middle fraction used for the measurements. The results were calculated in the same way as in the paper referred to, and they agree with the calculated and existing values within the limits of experimental error. F. J. B.

530. *Gas Currents in Tubes and Air Resistance of Globes.* **L. Schiller.** (Ann. d. Physik, 81. 8. pp. 866–868, Nov. 27, 1926.)—This paper consists mainly of remarks upon the work of Knodel on the subject [see Abstract 2753 (1926)]. After a brief reference to the earlier work of Liebster and Schiller on resistances of globes [see Abstract 1303 (1925)], the author limits himself to the consideration of the gas currents in tubes. A. E. G.

531. *Mobility of Small Spheres in a Gas, and their Electrical Charges.* **F. Ehrenhaft.** (Zeits. f. Physik, 39. 9. pp. 603–606, 1926.)—The constants of the law of resistance, as found by various observers for liquid and solid particles of radius greater than 10^{-5} cm., are collected. The mobility of all such particles is expressed in terms of the viscosity of the gas, the radius of the particle and the length of its mean free path. The charges on particles of smaller capacity than 3×10^{-5} cm. are smaller than the quantum of electricity, being in some cases only half as great as the latter. [Abstracts 2009 (1925) and 2497 (1926).] G. E. A.

532. *Mobility of Solid Spheres of Radius not Less than 10^{-5} Cm. and their Electrical Charges.* **H. Trebitsch.** (Zeits. f. Physik, 39. 9. pp. 607–622, 1926.)—Particles of selenium were observed in a gas at various pressures when subjected to an electrical force equal and opposite to gravity. Assuming the law of mobility, B, *viz.*,

$$B = \frac{1}{6\pi\mu a}\left[1 + \frac{l}{a}(A + De^{-Ca/l})\right],$$

where μ is the coefficient of viscosity, a the radius of the particle, l the length of the mean free path of the gas particles, and A, D and C constants, the values of A, D and C were determined from 155 series of observations, and were: $A = 1 \cdot 034$, $D = 0 \cdot 172$, $C = 2 \cdot 773$. With these constants, the radii of the particles and their electrical charges were found. Some charges were notably smaller than that on the electron, *e.g.* $2 \cdot 80 \times 10^{-10}$ e.s.u., and those particles with the smallest charges gave values of A which were in best agreement with the common value. The significance of this is shown to lie in the uniformity of the densities of the separate particles. Also, as a general rule, small charges are associated with small radii. Further, the existence of electrons ought to entail, under specific conditions, equality in the values of e/A, where e is the charge on the particle, whereas the tabulated values of e/A vary between $2 \cdot 6$ and $6 \cdot 0$. [See also preceding Abstract.] G. E. A.

533. *Mobility of Liquid Particles of Radius 10^{-5} Cm., and their Electrical Charges.* **M. Reiss.** (Zeits. f. Physik, 39. 9. pp. 623–630, 1926.)—Following a procedure similar to that described by H. Trebitsch [see preceding Abstract], observations were made with particles of saturated barium mercury iodide (BaHgIH) of density $3 \cdot 5$ in nitrogen. The constancy of the levitating voltage at different gas pressures indicates constancy of the mass of the particles. With the above substance the normal law of resistance holds for particles of sizes down to 10^{-5} cm. radius. These particles had electrical charges of from $4 \cdot 72 \times 10^{-10}$ to $3 \cdot 27 \times 10^{-10}$ e.s.u., *i.e.*, less than the electronic charge. G. E. A.

534. *Uniform Motion of a Round Cylinder in a Channel with Plane Parallel Sides.* **A. Masotti.** (Accad. Lincei, Atti, 4. pp. 359–363, Nov. 7, 1926.)—A study of the plane hydrodynamic problem of the uniform motion of a round cylinder along the axis of a channel with plane parallel sides on the hypothesis that the radius of the cylinder is small relatively to the width of the channel. Entirely mathematical.

E. F.

535. *Forces on a Cylinder in a Stream of Viscous Fluid.* **L. N. G. Filon.** (Roy. Soc., Proc. 113. pp. 7–27, Nov. 1, 1926.)—Formulæ are obtained for lift and drag when a solid cylinder is at rest in a stream of viscous incompressible fluid, no limitation being placed on the stream velocity, while the motions are assumed to be periodic in character and are termed quasi-steady. Equations of average motion are derived which, when second order terms are neglected, assume a linear form identical with those obtained by Oseen for a moving sphere. The equations are solved exactly and the complete set of typical solutions derived. An experimental method of testing the results is indicated. H. H. Ho.

536. *Primary and Secondary Vortices in Oscillating Fluids: Their Connection with Skin Friction.* **The late Mrs. H. Ayrton.** (Roy. Soc., Proc. 113. pp. 44–45, Nov. 1, 1926.)—The experimental part of the paper consists of a series of photographs relating to the pressure conditions existing at the end of a tank in which water is caused to oscillate, and to jets and vortices formed in oscillating water under various conditions [see Abstract 1183 (1915)]. It is shown that the three links in the chain of evidence as to the cause of the strong secondary vortices which form in water oscillating freely under the action of gravity, above and around those arising from the friction of the bottom, are: (1) The secondary vortices start where the jets and primary vortices are formed, and extend only as far down as the traces of these reach; (2) strong impulses are given to the secondary vortices in the water when falling while a new jet and primary vortex is forming, and only weak impulses are given in the rising water where there are only old jets and primary vortices which have lost much of their energy; (3) when the water is oscillating in such a way that the jets and primary vortices cannot form, the upper secondary vortices do not appear, while Lord Rayleigh's vortices, both upper and lower, form with great completeness, and exactly fulfil the conditions he predicted for them. H. H. Ho.

537. *Theory of Forced Vibrations.* **H. Schmidt.** (Zeits. f. Physik, 39. 5–6. pp. 474–489, 1926.)—If a system capable of vibration is subjected to the influence of a variable periodic disturbing force, then the vibrations peculiar to the system will be continually interfered with at the variable positions of the superposed disturbance. The present paper contains a mathematical investigation of the above problem, where the disturbing force is developed as a Fourier series and the solution then expressed in the form of trigonometrical series based on the fundamental linear superposition principle. H. H. Ho.

538. *Application of Diffraction Halos to Elasticity.* **J. P. Andrews.** (Phil. Mag. 2. pp. 945–947, Nov., 1926.)—When lycopodium is dusted on any polished plane surface, the image of a small light placed in front of it appears surrounded by circular coloured rings. On deforming the surface in any way the rings change their shape, and some measure of the strain may thus be obtained. The present paper contains a description of how Poisson's ratio may be determined by a method based on the above result. H. H. Ho.

539. *Oblique Rebound of a Sphere.* **R. C. J. Howland** and **T. W. Dickson.** (Phil. Mag. 2. pp. 1091–1098, Nov., 1926.)—A sphere is dropped on to a fixed inclined plane. Direct observation of its trajectory after rebound shows that e is practically constant, that the law of rebound alters at a certain critical angle when the ratio of the tangential to the normal impulse is slightly less than the coefficient of statical friction for the surfaces, that below the critical angle the tangential velocity component of the centre of the sphere is almost the same after impact as before, and that above the critical angle the ratio of the tangential to the normal impulse is less than the value at the critical angle. The angles of incidence and rebound satisfy equations of the type

$$\tan \alpha = a \tan \beta \quad \text{for } \alpha < \alpha_0$$
$$\tan \alpha = b \tan \beta - c \quad \text{for } \alpha > \alpha_0.$$

If a, b, c, and e are found for a pair of substances these equations give the law of rebound. G. A. S.

540. *Mechanism of the Fatigue Failure of Metals.* **H. F. Moore.** (Frank. Inst., J. 202. pp. 547–568, Nov., 1926.)—The accepted methods by which the stresses in engineering structures are calculated are based upon the assumption that the materials are continuous and homogeneous. But actually these materials are crystalline in structure and in consequence local forces occur which can differ considerably from the average forces as found by the usual methods. These local forces may be due to inclusions or minute cracks, and are not susceptible to calculation. In addition, owing to the variation in the crystalline orientation from grain to grain, the strength of adjacent grains may differ. It is these factors which have to be taken into account in considering the fatigue failure of metals. Examples are given of such failures together with the probable causes to which they are due, and a general theory of fatigue is considered based upon the ideas of Joffé and Griffiths. Both of these workers start from the conception of minute cracks in the metal which lead to local forces much greater than the average value, and it is owing to these local intensifications of stress that the cracks enlarge and the material fails. A. A. D.

541. *The Slip of Belts.* **R. Swyngedauw.** (Comptes Rendus, 183. pp. 859–861, Nov. 15, 1926.)—Among the successive positions taken by an element of the belt upon a pulley, there is one having characteristic properties, *viz.*, where the belt speed passes through a maximum when the pulley is moving. This critical position constitutes the subject of the present paper, and its determination for various conditions such as belt tension, angular velocity of pulley, etc., is considered, from which the adherence or slip of the belt is deduced. Experimental data are given in illustration. H. H. Ho.

542. *Non-Holonomous Spaces.* **G. Vranceanu.** (Comptes Rendus, 183. pp. 852–854, Nov. 15, 1926.)—In the study of holonomous mechanical systems a geometrical interpretation has been given by means of Riemann variables whereby certain results are expressed in particularly simple forms. The present mathematical paper extends this study to non-holonomous mechanical systems by introducing the idea of a non-holonomous variable. H. H. Ho.

543. *Theoretical and Experimental Foundation of General Stereochemistry.* **K. Weissenberg.** (Zeits. Elektrochem. 32. pp. 470–478; Disc., 478, Oct., 1926. Paper read before the Deut. Bunsen Gesell., Stuttgart, May, 1926.)—The author discussed the development of a general system of stereochemistry from theoretical and experimental data, especially the more recent investigations on crystal structure and atomic structure. The paper is not suitable for abstracting and the original must be consulted for details. F. J. B.

544. *Arrangement of the Microcrystals in Silver Deposited by Electrolysis.* **H. Hirata** and **H. Komatsubara.** (Kyoto Coll. Sci., Mem. 10. pp. 95–109, Nov., 1926. In English.)—The arrangement of the microcrystals in silver deposited electrolytically is examined with X-rays. The X-ray patterns appear to be due to the tendency of the microcrystals to deposit in a fibrous form, and to the parallel arrangement of the diagonal axes of the cubic crystals to each other as the axis of the fibrous form. AUTHORS.

545. *Surface Energy.* **M. Yamada.** (Tôhoku Univ., Sci. Reports, 15. pp. 323–330, July, 1926. In English.)—In a former paper the specific surface energy σ of a crystal surface was calculated by considering the cutting of a crystal by a plane. $\sigma = W/2F$, W = cutting work, F = area of one of the surfaces formed by cutting [see Abstract 1600 (1924)]. It was assumed that the specific surface energies of the two surfaces were equal; but this is not always true, and if the above formula holds good in all cases some hemihedral crystal forms, *e.g.*, the tetrahedron cannot appear. The author shows how the total surface energy of a crystal can be defined, but this does not determine the surface energy of each surface which remains entirely arbitrary. If, however, values are assumed for three plane surfaces those of other plane surfaces can be determined by means of an equation deduced. In the former paper an inclined surface was supposed to be formed of a group of simple surfaces like a staircase, but the results are affected by the circumstance here dealt with, and the present paper shows how this can be taken into account. Edge energy is also considered, and it is stated that similar discussions may be applied to corner energy. H. N. A.

546. *Behaviour of Single Crystals of Aluminium under Reversed Torsional Stresses.* **H. J. Gough, S. J. Wright** and **D. Hanson.** (Inst. of Metals, J. 36. pp. 173–188; Corres., 188–190, 1926.)—The effect of alternating torsional stressing on single crystals of aluminium is studied and the resulting distortion under this complex type of straining action is observed, using slip-band measurements, and is related to the atomic orientation of the crystals by means of X-ray analysis. The observed complicated system of slip-bands is then shown to be in agreement with the simple law that slip is confined, at any point of the surface of the crystal, to one of the octahedral planes and in the direction of the most highly stressed (shear stress) principal lines of atoms. The progressive hardening during a long endurance test has been studied, and the phenomena attending the last stages of the test have been isolated from those of the earlier stages. Some quantitative data regarding hardening by slip have been deduced from ball indentation tests made on cross-sections of the specimens used. The tests show that slip does not occur in the stages immediately preceding fracture. [See Abstract 1931 (1926).]

C. O. B.

547. *The Deformation of Tungsten Crystals.* **C. J. Smithells, H. P. Rooksby** and **W. R. Pitkin.** (Inst. of Metals, J. 36. pp. 107–115; Disc. and Corres., 116–120, 1926.)—Three sets of tungsten bars were prepared, A with a fine structure (2250 grains per sq. mm.), B formed of very large crystals, each of which occupied locally the full diameter of the rod, and C with a coarse structure (650 grains per sq. mm.). The rods were hammered from their original square section, 5·6 × 5·6 mm. to a circular section, and swaged down to 3·2 mm. diameter, specimens being examined during the process microscopically, after polishing and etching, and by the Debye-Scherrer X-ray method. The observations on rods B show that the first effect of swaging is to break up the crystals into comparatively large fragments; the X-ray evidence shows that when the area is reduced about 50 % the orientation of the fragments is random in almost all cases. Continued swaging elongates the fragments in the direction of working, giving in the end a fibrous structure; this is what takes place from the commencement with rods A. During this last process the X-ray patterns show an increase in the degree of preferred orientation, such as has been found by Burger in drawn tungsten. Rods C also give the fibrous structure, but the breaking up of the original crystals can be observed as with rods B; the X-ray patterns show that the original crystals give fragments of random orientation before the preferred orientation is developed. H. N. A.

548. *Crystal Structure of Rolled Nickel, Iron and Molybdenum Foil.* **S. T. Konobejewsky.** (Zeits. f. Physik, 39. 5–6. pp. 415–426, 1926.)—It is known that the plastic deformation of metals affects their crystal structure [see Abstract 1869 (1923)]. In particular it was shown that rolling gives a symmetry to the arrangement of the crystals about the direction of rolling. In this paper a general method is given for interpreting X-ray diagrams obtained under specified conditions. In rolled iron foil the direction of rolling becomes the 211 direction; in Ni it lies in the rhombododekahedral plane between 111 and 211, making an angle of some 8° with the latter. In some cases the diagrams depart from the usual appearance with microcrystalline media tending towards the amorphous type. Mo foil shows the direction of rolling to be 110. J. E.

549. *A Note on the Reply of Szivessy to the Criticism of his Paper: The Born Dipole Theory of Anisotropic Liquids.* **W. Kast.** (Zeits. f. Physik, 39. 5–6. p. 490, 1926.)—Szivessy holds [see Abstract 2770 (1926)] that, in spite of the conductivity of anisotropic liquids, the proof of their dipole nature must be established by statical measurements. The present author considers that his proof [see Abstract 2769 (1926)] was denied by Szivessy on very insufficient grounds, and he now submits a brief comparison of the degrees of accuracy of the respective standpoints in favour of his own claims. H. H. Ho.

550. *Method of Estimating Atomic Weights with the Aid of the Periodic Law.* **E. W. Washburn.** (Am. Chem. Soc., J. 48. pp. 2351–2352, Sept., 1926.)—The following graphic method seems to give a relationship between atomic weight and atomic number applicable to the estimation of most of the unknown atomic weights. The ratio of the atomic weight of each element to that of the next preceding (also succeeding) zero-group element is computed, and likewise the ratio between the corresponding atomic numbers. The differences between these ratios, when plotted against the atomic numbers of the elements, yield curves which for rows 1, 2, 3, 4 and 6 of the periodic chart are somewhat irregular, but for the other rows, containing the elements of unknown atomic weight, exhibit marked regularity. The differences between the ratios become smaller as the atomic numbers increase and approach zero for the last row in the chart. This relationship gives the following estimated values for atomic weights, the atomic numbers being given in brackets: masurium (43), 97·5 or 98·8; illinium (61), 146·0; rhenium (75), 187·4; eka-iodine (85), 212; eka-cæsium (87), 223; actinium (89), 229; proto-actinium (91), 234. T. H. P.

551. *The Characteristic Frequencies of Tetrahedral-Shaped Molecules.* **K. Rolan.** (Zeits. f. Physik, 39. 7–8. pp. 588–600, 1926.)—The case of SO_4^{--} is treated numerically. The polarisation of O^{--} and its distance from the positive ion are calculated from the observed frequencies and are found to be in agreement with the known values. [See also Abstract 2435 (1925).] J. E.

552. *Oscillation Energy of Molecules of CO and CO_2.* **F. Matossi.** (Zeits. f. Physik, 40. 1–2. pp. 1–3, 1926.)—The deformability α of the molecules of CO and CO_2 is calculated from the electrical moment of the molecules. The calculation of α from the proper frequency does not succeed, since the usual energy rate fails. A. E. G.

553. *Rotational Energy of Polyatomic Molecules.* **E. E. Witmer.** (Nat. Acad. Sci., Proc. 12. pp. 602–608, Oct., 1926.)—The molecule is regarded as a rigid body and has three principal moments of inertia. The method followed is based on that of Epstein and Kramers, and allows one of the phase integrals to be readily evaluated while the other is an elliptic integral containing the energy as a parameter. It is evaluated for all significant values of the energy, which is given as an explicit function of the quantum numbers. A. Wh.

554. *Spinning Electron.* **A. W. Conway.** (Roy. Irish Acad., Proc. 37. pp. 52–57, July, 1926.)—Purely mathematical. The problem considered is of a spinning electron describing an orbit about a fixed nucleus. The axis of angular momentum is invariable at a fixed angle to an axis of the electron. The electron orbit lies in a plane whose normal is in the plane of the two axes, makes a constant angle with the invariable axis, and rotates about this axis with an angular velocity which is in general non-uniform. A. Wh.

555. *Atomic Dimensions.* **J. D. van der Waals, Jr.** (K. Akad. Amsterdam, Proc. 29. 7. pp. 899–900, 1926. In English.)—De Broglie, Einstein and Schrödinger have identified protons, electrons and quanta with periodic phenomena defining the time dependence of the phenomena. The author suggests that this view can be modified so as also to involve the spatial limitations of the atoms. A. Wh.

556. *Millikan Rays and Atomic Transformations.* **M. B. Snyder.** (Am. Phil. Soc., Proc. 65. 3. pp. 161–169, 1926.)—The author recapitulates the development of his theory of universal atomic volcanism and identifies the Millikan penetrating radiation with the limit of the K series at atomic number 143. If N represents an atomic number and C the mass absorbtion coefficient for its radiation, a relation is used $C_z = C_e \times N_e^5/N_z^5$, where the suffix *z* refers to atomic number 143. A. Wh.

557. *The Limiting Atomic Number.* **M. B. Snyder.** (Am. Phil. Soc., Proc. 65. 3. pp. 170–182, 1926.)—Several considerations have led to the conclusion that the limiting atomic number is 143 [see preceding Abstract]. In this paper these are collected and reviewed with the details of the data from which the estimate of this number has been made. A. Wh.

558. *Method of Molecular Rays. Part I.* **O. Stern.** (Zeits. f. Physik, 39. 10–11. pp. 751–763, 1926.)—A discussion is given of the method of molecular rays as used in the determination of the magnetic moment of silver atoms, etc. From an oven filled with gas or vapour the molecules stream out through a narrow slit into an evacuated enclosure. A screen containing a similar slit placed opposite the oven opening selects out a fine pencil of molecules which is caused to impinge on a suitable receiving plate and form a visible deposit. Any desired forces are brought to bear on the molecules between the screen and the receiving plate, and the displacement of the image deposit is measured. The conditions necessary to obtain maximum sensitivity, which is limited by the available intensity of the ray pencil, are examined in detail. It is found most advantageous to work with an oven slit as small as mechanically possible. By the use of a " multiplicator " device in applying the deflecting field the sensitivity can be increased materially. The method is stated to be specially suited to deal with the following problems: (1) the measurement of the magnetic moment of molecules, both the electron moment of the order of one Bohr magneton and the nuclear moment of the order of 1/2000 Bohr magnetons; (2) the measurement of the electric moment of molecules; (3) the measurement of the field of force between molecules; and (4) the detection of (*a*) Einstein's radiation reaction and (*b*) the de Broglie waves. W. S. S.

559. *Method of Molecular Rays. Part II.* **F. Knauer** and **O. Stern.** (Zeits. f. Physik, 39. 10–11. pp. 764–779, 1926.)—The authors describe fully the construction and manipulation of the molecular-ray apparatus developed in accordance with the principles laid down in Part I [see preceding Abstract]. A necessary requirement was parallelism of the oven and screen slits. Optical methods proving unsatisfactory, the molecular rays themselves were used to make the adjustment. A number of large surfaces cooled with liquid air served to collect any stray molecular rays which might otherwise reach the receiving plate. The lines of deposit were examined in a vacuum with a microscope reading through a suitable window. Receiving plates of silver, copper, brass, zinc and

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platinum were all tried, but the silver plate gave deposits which were most easily visible and in addition could be most easily intensified. It was verified that using long narrow slits, an intense beam of molecular rays could be obtained. A beam 20 cm. long and 1/100 mm. in breadth still gave, after exposure of about ten seconds, a deposit line visible without intensification. W. S. S.

560. *Detection of Small Magnetic Moments of Molecules.* **F. Knauer** and **O. Stern.** (Zeits. f. Physik, 39. 10–11. pp. 780–786, 1926.)—Using the method of molecular rays [see the preceding two Abstracts], an attempt was made to detect the nuclear magnetic moment of mercury atoms, which may be expected to amount to either 1/1860 or 1/3721 Bohr magnetons. To obtain the necessary deflection, the molecular rays were passed through the inhomogeneous field formed between a groove in an iron plate and an opposite smooth plate, the plates forming part of the magnetic circuit of a horseshoe magnet. A special " multiplicator " device was employed. In none of the experiments, using mercury rays, was it possible to assert definitely that a deflection had occurred. In order to see if the apparatus was capable of detecting the nuclear moment, molecular rays of hydrogen were tried for which a magnetic moment of the same order as the nuclear moment is to be assumed. In this case it was possible to detect a slight displacement of the deposit on the receiving plate. Various reasons are advanced for the failure to obtain a positive result in the case of mercury. W. S. S.

561. *Wave Theory of Matter.* **G. Gamow** and **D. Iwanenko.** (Zeits. f. Physik, 39. 10–11. pp. 865–868, 1926.)—O. Klein and V. Fock have shown that by introducing the fifth coordinate Schrödinger's wave equation can be brought into the special form $\Box\psi = 0$ [see Abstracts 309 and 310 (1927)]. It is here shown how, in the absence of gravitational and electro-magnetic fields, an infinitesimal bundle of plane wave solutions of this equation, all having the period h in the fifth coordinate, correspond to a moving particle with which is associated a frequency equal to that of the "internal process" of de Broglie. The extension to the general case with gravitational and electromagnetic fields is considered briefly.

W. S. S.

562. *Passage of Corpuscular Rays through Matter.* **A. Becker.** (Phys. Zeits. 27. pp. 745–748, Nov. 15, 1926. Paper read before the Deut. Naturforscher u. Ärzte, Düsseldorf, 1926.)—In this paper a comparative study of the behaviour of matter towards different corpuscular radiations is used to lead to a knowledge of the general law which governs the procedure of the transference of energy to the atom of matter. A. E. G.

563. *Law of Force between Electrons, Two Electron Orbits and Models of the Helium Atom.* **A. W. Conway** and **G. Keating.** (Roy. Irish Acad., Proc. 37. pp. 40–51, July, 1926.)—The failure of the usual application of the quantum principle to the helium atom to give series formulæ of the correct type or a good agreement with the ionisation potential is ascribed to the failure of the inverse square law under these conditions. In this paper, which is mainly mathematical, the correct spectral and ionisation quantities are taken and the law of force necessary to fulfil the conditions investigated. A. Wh.

564. *Principles of Undulatory Mechanics.* **L. Flamm.** (Phys. Zeits. 27. pp. 600–617, Sept. 15, 1926.)—The author gives an outline of the notions underlying Schrödinger's undulatory mechanics [see Abstract 2017 (1926)]. The relativity mechanics of a mass particle are derived in the form of variation principles and the analogy with Fermat's principle and Huyghens' construction is developed. The de Broglie " phase waves " are introduced, and it is shown how the quantum condition for stationary states is equivalent to a condition for the production of standing waves of the phase wave scalar ψ. As an example the stationary states of a volume of perfect gas are determined. Finally, the Schrödinger wave equation is derived and a brief *résumé* given of the results obtained by its aid. W. S. S.

565. *The Schrödinger Wave Equation and Four-Dimensional Relativity Mechanics.* **J. Kudar.** (Phys. Zeits. 27. pp. 724–725, Nov. 15, 1926.)—Schrödinger has shown [see Abstracts 2541 (1926) and 306 (1927)] that the three-dimensional wave equation is identical with the equation, $[H, \psi] - E\psi = 0$, wherein E is the energy and [H,] a linear differential operator which is determined by the Hamiltonian function of the classical mechanical problem. In quite analogous manner the author now derives a four-dimensional wave equation which is valid for relativity mechanics. H. H. Ho.

566. *A Contribution to Wave Mechanics in Non-stationary Fields.* **L. Flamm.** (Phys. Zeits. 27. pp. 733–735, Nov. 15, 1926. Paper read before the Deut. Naturforscher u. Ärzte, Düsseldorf, 1926.)—L. de Broglie, Einstein, and Schrödinger have developed wave mechanics for the explanation of quantum phenomena, while Schrödinger [see Abstract 2017 (1926)] has investigated the rôle of wave mechanics in classical physics. In addition there are the Hamiltonian analogies between dynamics and optics. The present mathematical paper is an attempt to effect the generalisation of the above groups of ideas, and deals with wave mechanics in non-stationary fields. In the *Discussion*, **Noether** pointed out that the equations under review did not refer to the special Schrödinger theory, which proceeded from the partial differential equation of the second order, but only to an intermediate expression between classical mechanics and the new theory. H. H. Ho.

567. *Derivation of the Klein-Fock Equation.* **D. Iwanenko** and **L. Landau.** (Zeits. f. Physik, 40. 1–2. pp. 161–162, 1926.)—In this brief mathematical note it is shown that the generalised Schrödinger equation [see Abstract 2017 (1926)] may be obtained by a transition from the relativity analogies of the Hamiltonian problem. H. H. Ho.

568. *The Adiabatic Principle in Quantum Mechanics.* **M. Born.** (Zeits. f. Physik, 40. 3–4. pp. 167–192, 1926.)—In this mathematical paper, based on the statistical conception of quantum mechanics which the author, in a previous publication [see Abstract 43 (1927)], has briefly developed for impact processes, it is shown how an analogous hypothesis to that of the Ehrenfest adiabatic principle may be formulated and established. H. H. Ho.

569. *Operator Calculus and the Solution of the Equations of Quantum Dynamics.* **C. Eckart.** (Phys. Rev. 28. pp. 711–726, Oct., 1926.)—

A formal calculus is developed which includes the Born and Jordan matrix dynamics, and also the remarkable quantum condition of Schrödinger. A method for the calculation of the matrices which is in close analogy to the classical Hamilton-Jacobi method of solving dynamical problems is explained. These results have been obtained independently by E. Schrödinger [see Abstract 2024 (1926)]. AUTHOR.

570. *Graphical Representation of the de Broglie Phase Waves in the Five-Dimensional Universe of O. Klein.* **P. Ehrenfest** and **G. E. Uhlenbeck.** (Zeits. f. Physik, 39. 7–8. pp. 495–498, 1926.)—De Broglie's conception of the motion of an electron under no forces as being essentially the propagation of groups of waves [see Abstract 1329 (1925)] is interpreted in terms of the theory of a five-dimensional universe developed by Klein [see Abstract 2541 (1926)], and a simple geometrical representation of such motion is given. J. S. G. T.

571. *Extension of the Newtonian Potential by Means of Energetics.* **Sauger.** (Comptes Rendus, 183. pp. 868–870, Nov. 15, 1926.)—From analogy with the expression for the kinetic energy of a particle in uniform motion, the expression $GM(1 + aGM/rc^2 + v^2/2c^2)/r$ is derived for the potential of the dynamic gravitational field of a moving particle. J. S. G. T.

572. *The Gravitational Field in the Interior of a Hollow Rotating Sphere on the Theory of Relativity.* **J. Chazy.** (Comptes Rendus, 183. pp. 854–856, Nov. 15, 1926.)—On the Newtonian theory the attraction of a hollow homogeneous sphere, whether at rest or rotating, upon an interior point is zero. Thirring, however, has shown [see Abstract 449 (1919)] that on the relativity theory, if a homogeneous hollow sphere rotates about a fixed axis with constant velocity, then an infinitesimal mass near the centre is subjected to three inertial effects. These effects are now mathematically discussed, since the author opines that Thirring's expressions for the radial centrifugal force and the force parallel to the axis are incomplete to the degree of approximation considered. The components of the forces are now found to be three-fourths of the Thirring values, although the sense of the forces is unchanged. H. H. Ho.

METEOROLOGY AND GEO-PHYSICS.

573. *Vertical Distribution of Atmospheric Eddy Energy.* **C. G. Rossby.** (Monthly Weather Rev. 54. pp. 321–332, Aug., 1926.)—The vertical variation of atmospheric eddy viscosity (c_m) and its relation to the distribution of temperature and wind with height, the connection between c_m and the chief factors which regulate the production and consumption of atmospheric eddies, the vertical stability of the stratification and the rate of shearing between superimposed layers with different horizontal velocities are examined theoretically. It is shown that the production of eddy energy per unit mass and time is equal to the product of the atmospheric eddy energy per unit mass and the eddy productivity. Even a comparatively high lapse rate of 0·7° C./100 m. is very effective in suppressing eddy diffusion currents. With stable stratification diffusion will never reach beyond certain limits, but when unstable, eddies travel with increasing velocity to infinity. An equation is derived to give the simultaneous changes in E and θ (potential temperature) when two infinitely thick air layers are separated by a thin superadiabatic layer and overturning sets in. The solution is applied to the cause of certain thunderstorms. Since near the ground $E \propto \sqrt{h}$, and also E and c_m are proportional, the stationary distribution of E in a limited atmosphere can be compared with the known values of the variation of c_m with the height, and fair agreement results. R. S. R

574. *Observations of Twilight Arcs and Zodiacal Light in Greenland.* **A. Wegener.** (Akad. Wiss. Wien, Ber. 135. 2a. 7–8. pp. 323–332, 1926.)—Preliminary account of observations made by Koch's expedition at the "Borg" station, N.E. Greenland, in the winter of 1912–13, on the disappearance of the various twilight arcs and the zodiacal light. After the fading of the principal arc two others were observed, the last being in midwinter at midnight about 20° above the horizon. In brightness and silvery appearance it resembled the Galaxy. In the hours preceding midnight this twilight arc, the summit of which is always over the position of the sun, extends towards the left into the zodiacal light, which is of equal intensity. The apex of the zodiacal light pyramid lies towards 9 p.m. on the horizon, about 120° to the left of the solar azimuth, but rises by midnight to about 20°. In the second half of the night the last twilight arc shows a corresponding extension to the right, but the pyramidal form of the zodiacal light is not perceptible, and towards the left there is darkness. In February the zodiacal light could be seen in the evening together with, but fainter than, the post twilight arc. It would appear from these observations that the zodiacal light is to be considered as an atmospheric twilight phenomenon. It is especially interesting to note the great altitude, exceeding 700 km., of the air strata involved in the formation of the final arc. E. F.

575. *Atmospheric Dust and Condensation Nuclei.* **R. K. Boylan.** (Roy. Irish Acad., Proc. 37. pp. 58–70, Sept., 1926.)—Two series of experiments were made on the concentration of nuclei and dust particles (1) in the atmosphere, and (2) under artificially controlled conditions. For (1) an Owens jet dust counter [see Abstract 1457 (1922)] was used, observations being taken mostly at noon almost daily from October 1925 to June 1926. It was found that (1) the average concentration of the larger ions of one sign is appreciably less than Aitken's value probably due partly to the Aitken instrument reading too high, (2) the average number of dust particles per c.c. of the air of Dublin is 1580, while the average number of condensation nuclei per c.c. is 23,800, (3) rain and snow reduce the dust content, and increase slightly the number of nuclei, (4) the highest concentration of dust and nuclei occurs during fog, and (5) the correlation coefficient between the concentrations of dust and nuclei is $0{\cdot}73 \pm 0{\cdot}056$. Further, from the controlled tests it was shown that (1) dust particles will not act as nuclei of condensation even in spaces from which ordinary nuclei have been withdrawn, and (2) nuclei combine readily with dust particles, so that where dense dust clouds are created nuclei are completely removed. This last effect may be of considerable importance in the air of large cities. R. S. R.

576. *Atmospheric Pollution. Summary of Twelfth Report of the Advisory Committee.* (Meteorolog. Office, M.O. 290. [52 pp.], Nov., 1926.)—This report, proposed by the secretary, J. S. Owens, gives an account of the work of the Committee during the year ending March 31, 1926. Section I deals with the measurement of the impurities deposited from the atmosphere as obtained by the standard gauge. During the year sixty-one gauges were in use, an increase of twelve over the previous year, twenty-nine authorities cooperating in the collection of data. At about two-thirds of the stations the amount of impurity deposited during the year was less than the average for the previous five years, while in one-third it was greater. In Section II the impurity suspended in the air as measured by the automatic filter is discussed. Included under the observations with the jet dust counter in Section III is an account of the observations made in America, where the relationship found between the suspended impurity and the wind velocity confirms the result of a similar investigation published in the eleventh report. Section IV describes various researches, including an attempt to correlate the obstruction of the ultra-violet radiation with the quantity of the suspended impurity in the atmosphere. An Appendix, written by **J. R. Ashworth**, describes an instrument designed by him for measuring the amount of deposit from the atmosphere day by day, or hour by hour. The results obtained with the instrument are described, including a discussion of the effects of wind and rain on the quantity of matter deposited.

577. *Pressure Distributions Associated with Wet Seasons in the British Isles.* **C. E. P. Brooks.** (Roy. Meteorolog. Soc., J. 52. pp. 387–401; Disc., 402–403, Oct., 1926.)—[See also Abstract 2781 (1926).]

578. *Classification of Monthly Charts of Pressure Anomaly over the Northern Hemisphere.* **C. E. P. Brooks** and **Winifred A. Quennell.** (Meteorolog. Office, Geophys. Mem. 31. [11 pp.], 1926.)—Data from 114 stations in the northern hemisphere for the period 1873–1900 were employed and charts of the deviation from monthly mean pressure constructed. These charts were classified according to pressure anomalies in the region Greenland, Iceland, Scandinavia and British Isles, and then divided into two groups with the pressure at Thorshavn above or below normal. These groups are each divided into five types, and these again into several sub-types. Reproductions of these sub-types are given, together with details of each. The frequency of each type for winter and summer and the sequence of types are tabulated. R. S. R.

579. *Report on Winter Thunderstorms in the British Islands for January 1 to March 31, 1925.* **S. M. Bower.** (Roy. Meteorolog. Soc., J. 52. pp. 405–411; Disc., 411–414, Oct., 1926.)

580. *Abnormal Rates of Ascent of Pilot Balloons in the Lower Levels of the Atmosphere at Melbourne.* **E. Kidson.** (Roy. Meteorolog. Soc., J. 52. pp. 415–424; Disc., 424–426, Oct., 1926.)

581. *The Heterogeneous Fluid Ellipsoid in Rotation and the Theory of Continental Drift.* **P. Dive.** (Arch. des Sciences, 8. pp. 175–198, July–Aug., 1926.)—The author deals essentially with the state of equilibrium of celestial bodies and particularly with that of the earth. Mathematical expressions are developed to find under what conditions the rotation impressed upon the molecules of a fluid can preserve the ellipsoidal form of the layer. The angular velocity for any point in the layer is found, and the variation of this quantity with latitude and depth. The results are collected in tabular form. In general the author finds that the angular velocity decreases constantly from the centre to the surface and from the poles to the equator, save perhaps in two extreme cases of which one was given by Clairaut. Allowing for the viscosity of the terrestrial fluid he finds that the surfaces of sima are drawn along by friction by the rotation of the central core. The results are sufficiently correct to apply the theory qualitatively to test Wegener's theory for the earth. Wegener's and other views are discussed, and the author examines the effect of his theory on the separation of Europe and America, the depth of penetration of Eurasia and America into the sima and the formation of several large mountain masses and lakes. R. S. R.

582. *Nature of Earthquake Motions Examined by a Seismic Vibration Analyser.* **K. Suyehiro.** (Imp. Acad. Tôkyô, Proc. 2. pp. 268–270, July, 1926.)—A seismic vibration analyser, of which details are given, has been devised by the author (1) to detect, if any, the prevalent periods of earthquakes in a district, and (2) to study the nature of the vibration which is generally assumed to be harmonic. Records from six earthquakes at Tôkyô of " weak " category have been obtained, two records being reproduced. Harmonic motions are detected of which a period of 0·3 sec. is clear and that of about 1·4 sec. more or less conspicuous, these indicating natural periods for the district. The waves of 0·3 sec. occur intermittently during the earthquake indicating that at the focus of the earthquake the failure of the crust does not generally occur all at once. In one case the motion was composed of trains of harmonic motions of different periods, and probably in this case the failure of the crust may have occurred at one time. R. S. R.

583. *Relation of Isostasy to Seismology.* **W. Bowie.** (Am. J. Sci. 12. pp. 415–418, Nov., 1926. Paper read before the Seismological Soc. of America, May, 1926.)—The author states that from geodetic evidence and deductions there must be a different condition from the surface down to a depth of 60 miles from that in the subcrustal material below this level. The isostatic condition is disturbed by the shifting of material over the earth's surface and the effects of sedimentation and erosion in this connection are examined. The effect of temperature changes on the formation of mountain ranges and of synclinoria is dealt with. It is concluded that isostatic results may assist in the location of earthquakes in geographic position and depth and in the search for the causes of the earthquakes and the effect of the earthquake on surface configurations. [See Abstract 492 (1925).] R. S. R.

584. *Gravity and Isostasy.* **A. H. Miller.** (Roy. Astron. Soc. Canada, J. 20. pp. 327–334, Nov.–Dec., 1926.)—The rigid crust and isostatic anomalies for 41 stations are compared, and it is shown that the isostatic anomalies are consistently the smaller. Recent observations in the Caucasus support this, and it can be stated that the theory of isostasy is in accord with local gravitational observations. A. Wh.

ASTRO-PHYSICS.

585. *The 1925 Corona.* **F. Slocum.** (Astrophys. J. 64. pp. 145–148, Oct., 1926.)—The path of totality of the eclipse of the sun of January 24, 1925, passed directly over the van Vleck Observatory. The duration of totality at that point was 112 sec. Photographs of the corona and prominences were made with the 20-in. visual refractor and other instruments. The corona is of an intermediate type. The equatorial wings and polar rays are characteristic of the minimum sunspot coronas, but there is a perfect coronal dome, terminating in a long spike, which is a typical feature of a maximum of sunspots. AUTHOR.

586. *Theory of the Continuous Spectrum of the Corona.* **E. Pettit** and **S. B. Nicholson.** (Mount Wilson Observat. Contrib. No. 314. Astrophys. J. 64. pp. 136–141, Sept., 1926.)—Woltjer has calculated the distribution of energy in the continuous spectrum of the corona, based on the scattering of radiation by free electrons; and he finds that while it is identical with the distribution of energy in the solar spectrum in the photographic and visual region, the corona is much richer in energy in the far infra-red. Woltjer's theory is here discussed and compared with radiometric observations made at the eclipse of January 24, 1925, by means of a water-cell [see Abstract 697 (1926)]. It is shown that according to the classical theory of scattering by free electrons the water-cell transmission of coronal radiation should be 70 %, and according to that theory modified by the theory of quanta, as outlined by Woltjer, it should be 68 %, and the integrated solar radiation 72 %. These small differences can scarcely be detected by a single set of observations made at one eclipse, even under the best conditions. M. A. E.

587. *Graphical Reduction of Radial Velocities to the Sun.* **G. van Biesbroeck.** (Astrophys. J. 64. pp. 258–261, Nov., 1926.)—The reduction of radial velocities to the sun can be expressed simply as function of A, the right-ascension of the point in the sky toward which the earth's motion around the sun is directed. A can in turn be tabulated as a function of the calendar date. The multiplications involved are done by a thread stretched over a diagram drawn once for all. The result is given with a precision of 0·1 km./sec. No ecliptical coordinates of the star or longitudes of the sun are required. AUTHOR.

588. *Sunspots, the Magnetic Storm and the Aurora of October 13th.* **L. d'Azambuja** and **H. Grenat.** (Comptes Rendus, 183. pp. 701–703, Oct. 26, 1926.)—Phenomena connected with four groups of sunspots that were visible in the northern hemisphere on October 13th as observed with the Meudon spectroheliograph are described. The intensity of the disturbance is the greatest observed since 1909, when regular observations were begun. The disturbance had apparently not begun at 11h. 5m., was at its height at 13h. 15m. and had greatly declined at 14h. 41m. During the later stages there is evidence of the presence of large masses of hydrogen descending with a velocity of about 130 km. per sec. The magnetic disturbances apparently due to this eruption commenced about 31 hours after the spectroscopic observations first showed violent movements and came to a maximum 48 hours after the meridian passage of the affected area. About the same time there was some auroral activity. A. Wh.

589. *Flash Spectrum Observed at 1925 Eclipse.* **S. A. Mitchell.** (Am. Phil. Soc., Proc. 65. 2. pp. 99–104, 1926.)—A short popular account of the method and aim in obtaining slitless spectrograms of the chromosphere during a total solar eclipse. The results obtained at the van Vleck Observatory, Middletown, Conn., U.S.A., on January 24, 1925, by the author are: An experimental confirmation of Saha's theory of ionisation, and the heights of 14,000 km. for the ionised lines H and K of calcium, and of 12,000 km. for the red hydrogen line H_α. A. S. D. M.

590. *Photographs of Mars,* 1926. **F. E. Ross.** (Astrophys. J. 64. pp. 243–249, Nov., 1926.)—Photographs of Mars were made at Mount Wilson with the 60-in. reflector, in light of five different colours. The surface markings are portrayed by the longer wave-lengths, while the atmospheric clouds and haze are well brought out in the shorter wave-lengths. A cloud formation of unusual brilliance was photographed. The atmospheric rim-light is a feature of the ultra-violet pictures. The excess of diameter of Mars in the ultra-violet over the diameter in the infra-red, discovered by Wright, is confirmed. AUTHOR.

591. *Preliminary Classification of Nebulæ.* **K. Lundmark.** (Arkiv f. Mat. Astron. och Fysik, Stockholm, 19. No. 8. pp. 1–5, 1926. In English.)—It is desirable to classify nebulæ for statistical purposes, and also in order to trace, if possible, an evolutionary sequence among the spiral objects. It is suggested to divide all nebulæ into two main classes, those within and those without the Galaxy, and the author proposes to call these (i) Galactic and (ii) Anagalactic. The Galactic nebulæ are classified as (1) Planetaries, with subdivisions depending chiefly on the presence or absence of a central star and the ratio of its light to that of the total light of the nebula, and (2) Irregular gaseous nebulæ, subdivided into (*a*) bright and (*b*) dark. The Anagalactic nebulæ are classified as (1) Elliptical and Lenticular, (2) Spiral, and (3) the Magellanic Clouds and nebulæ resembling them, of which the author gives a list of about twenty. The Elliptical nebulæ are subdivided into six types, depending on the amount of condensation towards the centre, and the Spirals into six types depending on structure and amount of central condensation. All classes and sub-classes are represented by symbols; thus, a Galactic irregular bright nebula is Gib, a dark one Gid; an Anagalactic elliptical nebula only slightly condensed towards the centre is Ae1, strongly condensed Ae5, etc. The author considers that the evidence for the island-universe theory of Anagalactic nebulæ is at present rather strong. He gives parallaxes for the objects of Magellan Cloud type, calculated by himself, and ranging from 0″·0000010 to 0″·0000040. The system of classification is intended to apply to photographs taken with reflectors of apertures of 30 in. or more. M. A. E.

592. *Stellar Distribution and Colours in Cluster Messier* 34. **P. Collinder.** (Arkiv f. Mat. Astron. och Fysik, Stockholm, 19. No. 11. pp. 1–6, 1926. In French.)—The open irregular cluster, M34 (NGC 1039), is in + 42°·1 and 2^h32^m. The author obtained with the Zeiss triple objective (15-cm. aperture and 150-cm. focus) of the Upsala Observatory three plates of this region, of which two were for wave-lengths and one for photographic stellar magnitudes as compared with the Pleiades. The cluster has a radius of 20′; is composed almost wholly of dwarfs between magnitudes 8 and 12; and contains 60 stars brighter than $12^m\cdot5$ and only 64 brighter than 14^m, so that probably the fainter stars do not belong to it. Measured by the effective wave-lengths the distances of the stellar background and of the cluster are in parsecs 870 and 460 respectively; measured by colour index, the distance of the cluster is 400 parsecs as compared with Raab's determination of 450 and Trümpler's of 517. A. S. D. M.

593. *Distance of Open Cluster NGC 752.* **K. G. Malmquist.** (Arkiv f. Mat. Astron. och Fysik, Stockholm, 19. No. 13. pp. 1–4, 1926. In German.)—Exact photometric determinations of stars in a cluster are extremely valuable, for, as all the stars are at practically the same distance from us, their absolute magnitudes can be derived from their apparent magnitudes by means of a single constant, and the result will have an important bearing on the general distribution of the stars in space. The problem is to obtain the constant, that is, the zero point of the distribution in absolute magnitude. It can be obtained by taking the mean parallax of the brighter stars in the cluster, but for this we must have the colour indices as well as the photographic magnitudes. White giants have a great intrinsic brilliancy which varies but little, relatively, from star to star; therefore, we can observe all the white giants in a cluster and determine their mean apparent magnitude, and taking the mean absolute magnitude of this particular class we can immediately obtain the distance of the cluster. The distribution of absolute magnitude has been determined by the author for a certain range of colour-index, and the details of this determination will be given in a future paper. He here applies his method to the photometric measurements of the star-cluster NGC 752 carried out by Heinemann. He finds the mean apparent magnitude to be $13^{m}\cdot05$, and the distribution shows a marked division into two components, doubtless due to the presence of both giants and dwarfs among the stars observed. The distance deduced by this method is 1760 parsecs, corresponding with a parallax of $0''\cdot00057$, which agrees closely with that found by Heinemann, $0''\cdot0006$. M. A. E.

594. *Difference between the Visual and Bolometric Magnitude of Stars in Relation to Absolute Temperature.* **G. Armellini.** (Accad. Lincei, Atti, 4. pp. 337–342, Nov. 7, 1926.)—An entirely mathematical paper in which the author bases his calculations on Wien's approximate formula and arrives at results in close agreement with those of Hopmann. E. F.

595. *On Delaunay's Method.* **H. Andoyer.** (Comptes Rendus, 183, pp. 993–996, Nov. 29, 1926.)—Simplification of Delaunay's method. Entirely mathematical. E. F.

596. *Motion of Helium Stars.* **P. Stroobant.** (Comptes Rendus, 183. pp. 1020–1022, Nov. 29, 1926.)—After referring to work by himself and others [see Abstract 1581 (1910)] on B-stars as a whole, the author studies the general motion of the subsections, B8- and B9-stars, these being usually in low Galactic latitude (g). He divides the whole sky in three parts, of which the two polar sections contain 45 stars and the other part, the Galactic zone, contains 330 stars, and also divides this latter zone into twelve parts of Galactic longitude (G). He finds a motion of these helium stars in the direction G = 265°, $g = -3°$, with a velocity of 5 km. sec., and also that the general movement of translation is superposed on particular motions in the regions of Aquila and Cygnus on one side and of Perseus and Monoceros on the other. A. S. D. M.

597. *Spectrum of Nova Geminorum* (**1912**). (Lick. Observat., Publ. **14.** 2. pp. 27–91, 1926.)—A detailed description of the observations made at the Lick Observatory, and compared with Stratton's work on this same nova [Ann. Solar Phy. Obs. Cambridge, **4.** Part I]. The author notes that some deductions should be modified in view of the theory of ionised spectra, since developed. He pays special attention to the occasional lapses in this nova from normal condition of the spectrum involving loss, dismemberment or obliteration of bands (broad emission lines); these lapses are recrudescences of a spectral condition known as the 4640 stage [pp. 84–90], which in past novæ has preceded the nebular line stage. He examines its spectra when it was in the Wolf-Rayet stage (1914–15), and concludes that there is no difference in the behaviour of the two principal nebular lines. A. S. D. M.

598. *Redetermination of Radial Velocity Curves of Certain Cepheid Variables.* **T. S. Jacobsen.** (Lick Observat., Bull. **12.** No. 379. pp. 138–154, 1926.)—The author admits some sort of pulsation as the cause of Cepheid variation [see Abstract 2455 (1925)]. He endeavours to determine the precise form of the radial velocity curves and the change in width of the spectral lines with the phase of light variation reported by some observers for four bright Cepheids. He finds for δ Cephei, between 1908–23, an average spectrosopic apparent period of $5^d \cdot 366331$, that is a shortening, with increase of longitude of periastron and of the velocity of the system; for η Aquilæ, between 1898–20, a period of 7 ·176659, that is a lengthening; for ζ Geminorum, between 1899–23, $10^d \cdot 15253$, that is a shortening, and also that the variation in width with phase is small; for W Sagittarii, a difference in shape in curves for 1903 and for 1923–24, which is real, but partly due to variations in blend effect with changing spectral type. The so-called atmospheric pulsation effect at different absorption levels was evidenced in η Aquilæ only, and that slightly. A. S. D. M.

599. *Statistical Properties of Galactic Cepheids having Periods Longer than One Day.* **J. Schilt.** (Mount Wilson Observat. Contrib. No. 315. Astrophys. J. **64.** pp. 149–166, Oct., 1926.)—In the region of Sagittarius and Aquila the frequency-curve shows a maximum for $\log P = 0 \cdot 84$. The maximum for other regions of the galaxy is for a decidedly shorter period. The period of maximum frequency for the Cepheids in the Small Magellanic Cloud is about the same as for the galactic Cepheids in the hemisphere opposite to the Sagittarius-Aquila region. The present material shows that the median apparent magnitude, median proper motion, and median absolute magnitude are systematically small for log P between $0 \cdot 8$ and $1 \cdot 0$. There is no decrease of apparent magnitude and proper motion for periods longer than ten days, as would be expected from a uniform distribution in density and velocity. The fact that the absolute magnitudes derived from the motions of the fainter Cepheids differ appreciably from the generally adopted values based on thirteen Boss stars indicates the importance of obtaining both accurate proper motions and additional radial velocities for these stars. AUTHOR.

600. *Two New Variable Stars of the Type of W Ursæ Majoris.* **J. Schilt.** (Mount Wilson Observat. Contrib. No. 316. Astrophys. J. **64.**

pp. 215–224, Nov., 1926.)—The variability of 44*i* Boötis (fainter component) = Boss 3846 = Σ 1909 (ft.), and of B.D. + 75°752 = Cin. 4000, have been investigated on account of peculiarities in their spectra. The variability of both stars is demonstrated. The periods of revolution (*i.e.* the double light-period) are of the order of 0^{d}·3, and the light-curves very much resemble that of W Ursæ Majoris. The range of magnitude is about 0·7 for 44*i* Boötis and 0·35 for B.D. + 75°752. 44*i* Boötis is of special interest because it is a component of a visual binary of well-marked orbital motion and of large parallax. Both stars have large proper motions. AUTHOR.

601. *Absolute Magnitudes and Parallaxes of* 410 *Stars of Type M.* **W. S. Adams, A. H. Joy** and **M. L. Humason.** (Mount Wilson Observat. Contrib. No. 319. Astrophys. J. 64. pp. 225–242, Nov., 1926.)—Magnitudes and spectral types have been determined for 410 M-type stars (Table I). Nearly all Boss stars north of − 30°, several stars from the Selected Areas, and about 100 dwarf stars of this type have been included. The stars were classified from M0 to M7 on the basis of the titanium bands. The absolute magnitudes were determined according to methods previously employed with the aid of additional lines and new reduction curves. λλ4077, 4207, 4215, 4258, Hγ, 4389, 4489, and Hβ were used for giants and λλ4318, 4435, 4454, 4535, 4586, and 4607 for dwarfs. The reduction curves were calibrated with the aid of mean parallaxes derived from peculiar motions for the giants and trigonometric parallaxes for the dwarfs. Twenty-eight stars are brighter than − 1·0 mag. and are called "super-giants." The ordinary giants show very little dispersion in absolute magnitude. The dwarfs vary with advancing type from + 7·0 to + 12·5 mag. Figures 1 and 2 indicate the relationship between type and absolute magnitude. The mean difference between the spectroscopic and the trigonometric parallaxes is less than 0″·001 for 71 giants. For dwarfs the mean difference is 0″·002. The absolute magnitudes of 165 giants average 0·4 mag. brighter than those previously published in a list of 1646 stars. A comparison with Young and Harper, and with Rimmer shows the Mount Wilson values to be fainter by 0·8 and 0·7 mag. respectively. AUTHORS.

602. *Spectroscopic Magnitudes of A-Type Stars.* **A. V. Douglas.** (Mount Wilson Observat. Contrib. No. 244. Astrophys. J. 64. pp. 262–270, Nov., 1926.)—A study of spectra of A-type stars has resulted in seven criteria being found by which absolute magnitudes and hence parallaxes may be determined. These criteria include both widths and relative intensities of lines. Parallaxes thus determined, when compared with trigonometric parallaxes and those from moving clusters and spectroscopic parallaxes from Mount Wilson and Arcetri, seem to indicate that a greater individual accuracy can be obtained by the use of such criteria than by adopting a statistical mean magnitude for each spectral subdivision. AUTHOR.

603. *The Dwarf Companion to Castor as a Spectroscopic Binary and Eclipsing Variable.* **A. H. Joy** and **R. F. Sanford.** (Mount Wilson Observat. Contrib. No. 320. Astrophys. J. 64. pp. 250–257, Nov., 1926.)—The spectral type of Castor C is *d*M1*e*. Hα. Hβ. Hγ, Hδ, and H and K of calcium are present as emission lines. In 1916 the star was found to be a spectroscopic binary, both bright and dark lines being double, and both spectra being nearly alike, except that one was somewhat stronger than the other. The period was found to be 0·814266 day, with no indication of eccentricity. Thirty-five spectrograms have been obtained as listed in Table I. Spectrographic elements were determined and corrected by a least-squares solution: $e = 0\cdot0$ (assumed); $\gamma = +4\cdot3$ km./sec. $K_1 = 114\cdot0$ km./sec.; $K_2 = 126\cdot7$ km./sec. A comparison of the orbits of the system of Castor is given in Table III. The intensities of the two absorption spectra are in the ratio of 5 : 4. The emission lines seem to be stronger when on the side of greater wave-length. They give the same velocities as the absorption lines. The spectroscopic absolute magnitude of the brighter component is estimated from plates showing single lines to be 9·2, which corresponds to a parallax of $0''\cdot083$. With the aid of van Gent's light-curve, photometric elements and absolute dimensions have been computed: $a_0 = 0\cdot88$; $k = 0\cdot89$; $i = 86^\circ\cdot4$; $a_1 + a_2 = 2{,}700{,}000$ km.; $r_1 = 0\cdot76 \odot$; $r_2 = 0\cdot68 \odot$; $m_1 = 0\cdot63 \odot$; $m_2 = 0\cdot57 \odot$; $\rho_1 = 1\cdot4 \odot$; $\rho_2 = 1\cdot8 \odot$. The surface brightness of both stars is 3·6 mag. fainter than that of the sun. AUTHORS.

604. *Orbits of Four Spectroscopic Binaries.* **R. F. Sanford.** (Mount Wilson Observat. Contrib. No. 317. Astrophys. J. 64. pp. 172–193, Oct., 1926.)—The star η Orionis, besides having a tenth-magnitude companion, has long been known as a close visual double. Recent observations indicate that the brighter of the two components consists of three stars, each about ten times as massive as our sun, two of which move round one another in a period of eight days. The H and K lines of calcium do not share in the varying velocity of the other lines in the spectrum, and the D lines of sodium are also constant, as with many other spectroscopic binaries of early B type. The velocity of the triple system, and of the D lines, is about + 17 km./sec., which is nearly the same as that of the Orion nebula, and η Orionis is situated on the inner edge of the large ring of nebulosity which surrounds the Orion nebula.

The multiple system ε Hydræ includes a visual pair of stars whose data are complete enough for the deduction of both its visual and spectrographic orbits, and thus their linear dimensions and the parallax of the system have been determined. A third star revolves round this pair in a period of 650 years, and there is a fourth with the same proper motion as the others, therefore probably belonging to the system.

Both spectra of the binary Boss 4247 have been photographed, hence the orbital elements of both components have been calculated. The period is 2·3 days, the orbits are circular, and the two stars appear to differ little in absolute magnitude from our sun.

B.D. + 57°2309 is a spectroscopic binary involved in nebulosity. Its spectral class is B3. The H and K lines, and probably also the D lines, appear to show a constant velocity, but the other lines have a varying radial velocity in two periods, of 5·4 days and 225 days. This may indicate that the star is a triple system, and its centre of mass seems to be at rest with regard to the nebulosity. M. A. E.

LIGHT.

605. *Naming the Common Signal Colours.* **M. Luckiesh and I. W. Moeller.** (Optical Soc. America, J. and Rev. Sci. Inst. 13. pp. 465–469, Oct., 1926.)—Twelve colours were chosen and viewed, (1) singly, and (2) collectively, and the names given to each by thirty-eight observers were compared with the names given by a Sectional Committee of the American Engineering Standards Committee on Code for Traffic Signals. The results are tabulated. It is shown that confusion arises in naming colours in the vicinity of blue-green and the transition point from yellow to red, while the names assigned are often different when the colours are viewed singly than when viewed among a group of other colours. The facts are of practical importance in the use of colours for traffic signals.
R. S. R.

606. *Absorption Colours of the Second Order.* **J. Piccard.** (Am. Chem. Soc., J. 48. pp. 2352–2354, Sept., 1926.)—As a rule any increase in the molecular weight of a coloured organic compound is accompanied by a change of the colour in the order, yellow to orange, red, violet, blue, green; the latter is followed by yellowish-green, yellow, orange, red, these colours being described as of the second order. The experimental data, as far as they go, are in agreement with the following theory. The colour of ordinary yellow dyes is produced by an absorption band, or a group of bands, entering the spectrum at the violet end. When the violet light is absorbed, the complementary yellow results, when the absorption band enters the blue, orange appears and so on, until, with the band at the red end of the spectrum, the dye becomes green. If further increase in the molecular weight produces further shifting of the band, this must leave the visible spectrum. In this case a colourless compound is not obtained, as a new band, the "octave" of the first, enters the visible spectrum at the violet end and thus gives rise to the yellow of the second order. From the fact that auramine does not absorb in the infra-red at $\lambda = 0{\cdot}8$ to $1{\cdot}0\mu$, the conclusion is drawn that it is not a dye of the second order and that it cannot have a quinonic constitution.
T. H. P.

607. *After-Images and Contrast in Coloured Light.* **G. Grijns and K. de Haan.** (K. Akad. Amsterdam, Proc. 29. 7. pp. 878–884, 1926.)—The results of the experiments are summarised in a table showing that in all the cases examined the colour of the after-image and the contrast constitute the remainder on subtracting from the colour of the light the colour in which the disc used in the experiments is seen. A more detailed publication is promised later.
W. H. Ge.

608. *Theory of Total Reflection.* **E. T. Hanson.** (Optical Convention, Proc. Part II. pp. 800–812, 1926.)—The theory of the diffraction phenomena which are observed when a beam of monochromatic light is incident, in the neighbourhood of the critical angle, on a glass-air interface, is considered. The obscure problem relating to the surface phenomena at or near total reflection is dealt with, and an attempt is made to explain some very interesting observations upon a subject that has received remarkably little attention. AUTHOR.

609. *Treatment of Reflection as a Special Case of Refraction.* **T. Smith.** (Optical Soc., Trans. 27. 5. pp. 312–316, 1925–1926.)—It is well known that reflection may be treated as a special case of refraction by assigning negative values to the refractive indices. The equation of reflection is frequently expressed incorrectly in optical treatises, and this erroneous relation immediately suggests the use of negative indices. The justification of the principle is considered in detail, and the subsidiary questions of sign in mixed reflecting and refracting systems are discussed. This leads to the computation of such systems on the supposition that the powers and reduced separations are independent of the direction in which the light is travelling at any stage of its passage through the system. AUTHOR.

610. *Derivation of the Formula* $(n - 1)/d = \text{const.}$ *for Feebly Refractive Media from the Quantum Theory of Light.* **K. Schaposchnikow.** (Zeits. f. Physik, 39. 10–11. pp. 863–864, 1926.)—The above formula is derived on the assumptions that (1) a light quantum describes a zigzag orbit in a refractory body as a consequence of electronic impacts, and (2) the velocity of a light quantum becomes smaller during the impact than the velocity of light. Compare the work of Ornstein and Burger. [See Abstract 1068 (1925).] H. H. Ho.

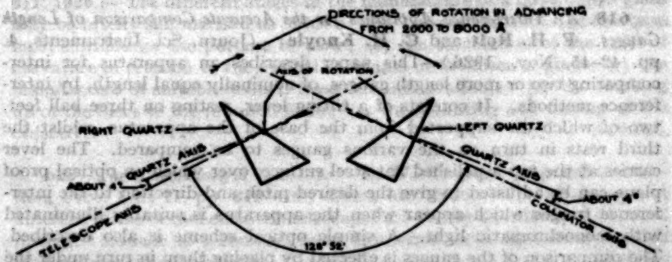
611. *Electric Double Refraction in Colloids.* **Y. Björnståhl.** (Phil. Mag. 2. pp. 701–732, Sept., 1926.)—The paper gives an account of electric double refraction in mercury, gold and sulphur hydrosols. The liquid was contained in a glass trough which also held the condenser plates to which was applied a pure sine e.m.f. wave of high frequency to avoid electrolysis. With a mercury sol the phase difference was proportional to the field intensity, and not, as is usual, to the square of the intensity. The possibility of a change in the shape of the particles as an effect of the current is discussed [see also C. Christiansen, Abstract 616 (1904), and Y. Björnståhl, Abstract 524 (1922)]. In a gold sol the double refraction was initially proportional to the square of the intensity, but afterwards approached a saturation value. The effect of the electric field increases with the size of the particles; and when the wave-length of the light is varied, a maximum phase difference is observed with $\lambda 6000$. With sulphur sols a deviation from the quadratic law was also noted; and measurements were made of electric dichroism with this substance. G. E. A.

612. *Optical Theory of Skiascopy.* **J. P. C. Southall.** (Optical Soc. America, J. and Rev. Sci. Inst. 13. pp. 245–266, Sept., 1926.)—Deals with the theory of the determination of the state of refraction of the eye. Experimental details are given, together with formulæ for the size of the "reflex circle" and the rate of movement of the reflex. The accuracy likely to be obtained is discussed. W. H. GE.

613. *Variation of Visual Sensory Reflex Action with Intensity of Stimulation.* **F. Allen.** (Optical Soc. America, J. and Rev. Sci. Inst. 13. pp. 383–430, Oct., 1926.)—In this paper there is first a brief *résumé* of

former investigations [see Abstract 1422 (1924)] on the Porter effect in regard to the retinal effects of varying the intensity of the light stimulus. Seventeen new Porter graphs have been obtained with bright colours, and, instead of only two branches that the Porter graphs were believed to have, from three to five were found. The effect upon the retinal sensitiveness was measured for intensities corresponding to each branch of the graphs. It was found that this consisted of depression or enhancement of the sensitiveness of the retina. The relation of these discoveries to the following visual phenomena is discussed: the Fechner paradox, the Purkinje effect, the receptor process in respect to the Hering, Edridge-Green, Ladd-Franklin and Young theories, the Weber-Fechner law, equilibrium effects, invariable colours, the self-light and sensation process, the duplicity theory, reciprocal innervation, and the partial reconciliation of the Young and Hering colour theories. AUTHOR.

614. *Quartz Ultra-Violet Monochromator.* **H. F. Kurtz.** (Optical Soc. America, J. and Rev. Sci. Inst. 13. pp. 495–501, Oct., 1926.)—



Describes the properties of the prism system shown diagrammatically in the figure. The two prisms rotate equally and simultaneously about the axes passing through the centres of the hypotenuses. The constructional details of the complete instrument are described and illustrated.

J. W. T. W.

615. *Solarimeters and Solarigraphs.* **L. Gorczyński.** (Monthly Weather Rev. 54. pp. 381–384, Sept., 1926.)—Particulars are given of two instruments designed to measure the radiation intensity of the sun at normal incidence. The instruments are simple in action, direct reading, portable and cheap. (1) The solarimeter is a combination of a thermopile of a modified Moll type, closed hermetically under a hemispherical glass cover and directly combined with an electrical measuring apparatus of a simple millivoltmeter type. Directions for using and testing the instrument are given. (2) The solarigraph consists of the above instrument fitted to a special holder for use permanently outdoors. The importance of sun and sky radiation measurements is emphasised. [See also Abstract 537 (1925).] R. S. R.

616. *Theory of the Duplex Monochromator.* **P. H. van Cittert.** (Rev. d'Optique, 5. pp. 393–403, Oct., 1926.)—The purity of the light issuing from a monochromator may be increased by placing a second monochromator behind the first, thus subjecting the transmitted light to a double filtration. Such an apparatus may be constructed in two different ways, the direction of the dispersion of the two monochromators being either identical or contrary. The intensity and purity of the light transmitted are here compared and determined. It is found that there is in each case an advantage in having the three slits of equal breadth, and that the duplex monochromator with contrary dispersion is preferable, since, in addition to other advantages, it allows no light to pass but that of the desired wave-length, whereas the other also transmits diffused light from neighbouring regions. The problems are treated mathematically. E. F.

617. *Shadow Fringes for Testing Optical Systems.* **V. Ronchi.** (Rev. d'Optique, 5. pp. 441–449, Nov., 1926.)—Shadow fringes are formed when a comparatively coarse grating is placed close to the focus of an optical system. Their nature is discussed, and it is concluded that they are interference effects of an achromatic character which form a test of the precision of the optical system. Some applications of this test are given. F. S.

618. *An Interference Appliance for the Accurate Comparison of Length Gauges.* **F. H. Rolt** and **C. H. Knoyle.** (Journ. Sci. Instruments, 4. pp. 42–45, Nov., 1926.)—This paper describes an apparatus for intercomparing two or more length gauges, of nominally equal length, by interference methods. It consists of a tilting lever, resting on three ball feet, two of which are supported from the base of the apparatus, whilst the third rests in turn on the various gauges to be compared. The lever carries at the top a polished flat steel surface, over which an optical proof plane can be adjusted to give the desired pitch and direction to the interference fringes which appear when the apparatus is suitably illuminated with monochromatic light. A simple optical scheme is also described. The comparison of the gauges is effected by placing them in turn under the third foot of the tilting lever, and counting the number of fringes, in whole numbers and tenths, which fall within a given space. The difference between the gauges in inches is then $K\frac{n_1 - n_2}{2}\lambda$, where n_1 and n_2 are the number of fringes produced by each gauge in turn, and λ is the wavelength (in inches) of the radiation used, and K is a constant depending upon the magnification of the lever arrangement. AUTHORS.

619. *Production of Optical Glasses.* **W. H. S. Chance** and **W. M. Hampton.** (Optical Convention, Proc. Part I. pp. 24–38; Disc., 38–40, 1926.)—Describes a number of new productions in absorbing glasses, notably (*a*) a range of coloured glasses to replace the gelatine filters generally employed for isolating various portions of the spectrum; (*b*) a special yellow glass for use as a "third colour" in railway signalling; (*c*) a glass of neutral colour absorbing strongly in the ultra-violet (Crookes' glass); (*d*) a roofing glass which absorbs most of the infra-red and is used for such purposes as factory glazing in tropical countries and for the roofs of airplane and airship sheds (Calorex); (*e*) a form of window glass which transmits far into the ultra-violet (Lamplough's Vitaglass); and (*f*) a daylight glass which, when used with a gas-filled electric lamp produces a light similar in spectral distribution to ordinary daylight. Many varieties of optical glass have been produced in this country, and 112 varieties are now available, including a very dense barium crown with a refractive index of about 1·61 and a ν value of between 55 and 60, $(n_D - 1)/(n_F - n_C)$. This glass has made possible the design of an $f/2$ lens. J. W. T. W.

620. *Modern Manufacture of Optical Elements.* **W. Taylor.** (Optical Convention, Proc. Part II. pp. 594–603, 1926.)—The original method of producing optical parts (chiefly lenses and prisms) was what the author terms the " artistic " method, *i.e.*, the use of more or less primitive tools by a highly skilled craftsman. The paper describes the many ways in which, largely as a result of war conditions, this method has now been replaced by the " scientific " method, *i.e.*, the use of carefully designed and often intricate machines capable of work of very high accuracy even when tended by comparatively unskilled labour. Some examples are given of the great precision which is now attained in the British optical industry. J. W. T. W.

621. *Manufacture of Large Astronomical Object Glasses.* **E. W. Taylor.** (Optical Convention, Proc. Part II. pp. 604–610; Disc., 610–611, 1926.)—The different stages in the manufacture of a large object glass may be briefly summarised as follows: (*a*) The determination of the type most suitable for the purpose in view; (*b*) the calculation of the radii of curvature in relation to the optical constants of the discs of glass; (*c*) the manufacture of suitable tools if these are not available; (*d*) the working up of the discs to the required form; (*e*) the mounting and testing of the objective. AUTHOR.

622. *The Tacheometric Telescope.* **E. W. Taylor.** (Optical Convention, Proc. Part II. pp. 612–619; Disc., 619, 1926.)—The advantages of different forms of tacheometric telescopes are briefly described, and special reference is made to a compact form of internal focussing telescope which may be considered anallatic. AUTHOR.

623. *Artificial Horizons.* **G. H. Carruthers.** (Optical Convention, Proc. Part II. pp. 636–640; Disc., 640–641, 1926.)—Discusses two requisites of the artificial horizon when used with a sextant or a prismatic astrolabe. (1) The mercury surface must be free from waves set up by vibration. This is normally effected by making the mercury pool very shallow. Suggestions having been made that if a deeper pool is used, the surface ripples could be eliminated by floating a piece of plane parallel glass upon the surface, this proposal has been tried out and found to be insufficiently accurate. (2) When the mercury is very shallow there is a possibility that when the amalgamed copper plate, upon which the pool is formed, is not level the upper surface of the mercury may not be exactly horizontal. Experiments were carried out to test the amount of tilt permissible before any inclination of the upper surface is perceptible. AUTHOR.

624. *Spirit Levels.* **S. Weston** and **V. Towns.** (Optical Convention, Proc. Part II. pp. 642–650; Disc., 650–652, 1926.)—The development of the spirit level is traced from the earliest to the present times, and the subject is dealt with under the headings: (1) Regularity of the curve and mountings. (2) Mobility of responsiveness of the air bubble. (3) Varying length of the air bubble with change of temperature. (4) Method of observation. Various new types of spirit levels are described. AUTHORS.

625. *Levelling Instruments.* **E. O. Henrici.** (Optical Convention, Proc. Part.II. pp. 663–668; Disc., 668–672, 1926.)—The paper deals with the alterations in the design of levelling instruments, as listed by English makers, since the date of the last Optical Convention (1912). The main alterations are: The introduction of internal focussing telescopes; arrangements for viewing the bubble from the observer's position at the eyepiece of the telescope; the introduction of a tilting screw so that the bubble is set for each staff reading, no attempt being made to set and keep the vertical axis truly vertical; the introduction of the "constant" bubble; the increased use of "reversible" bubbles for adjusting the instrument. Levelling staves have also been improved; the introduction of the parallel plate micrometer enables more accurate readings to be taken. Many minor improvements in mechanical design result in lighter, stronger, and more accurate instruments. AUTHOR.

626. *Survey Stereoscope and Contour Plotter.* **C. F. Smith.** (Optical Convention, Proc. Part II. pp. 673–680; Disc., 680–682, 1926.)—The paper describes a stereoscope suitable for the observation of photographs taken from the air for survey purposes. The direction of observation through the stereoscope is horizontal, or inclined downwards from the horizontal, while the prints are horizontal and placed in front of the operator in a suitable position for marking contours. The reflected images of the prints in mirrors placed vertically above are viewed by a binocular system. The conditions for orthostereoscopy are discussed, together with means for reducing the diameter of the Ramsden circle, based on the proportion of the photographic lens aperture to the distance of the object. AUTHOR.

627. *Optical Methods of Distance Measurement.* **J. M. Strang.** (Optical Convention, Proc. Part II. pp. 683–700; Disc., 700–701, 1926.)—The paper is confined to distance measurement for surveying purposes. The various general types of instruments are mentioned, but the paper is restricted to instruments of the single observation type, particularly the tacheometer and the short base coincidence range-finder. AUTHOR.

628. *New Single Reading Theodolite.* **T. F. Connolly.** (Optical Convention, Proc. Part II. pp. 702–706; Disc., 706–707, 1926.)—The paper describes a new theodolite in which one side of both circles are read in the same field of view. The reading microscope employs a fixed scale in the focal plane of its eyepiece. All observations are made without change of the observer's position. AUTHOR.

629. *Classification of Sextants.* **T. Y. Baker.** (Optical Convention, Proc. Part II. pp. 708–710, 1926.)—The paper discusses the tolerance for accuracy allowable in the National Physical Laboratory certificates and advocates a new type of certificate to be granted to sextants "suitable for ordinary navigation purposes." It is suggested that such a sextant should have a least reading of one minute and an allowable error of ± 1′ or possibly ± 2′. AUTHOR.

630. *Sextants by Mass Production.* **T. Y. Baker.** (Optical Convention, Proc. Part II. pp. 711–718; Disc., 718–719, 1926.)—Proposals are put forward for the design of a sextant suitable for ordinary navigation in which the methods of construction are such as to minimise cost without loss of accuracy. The proposed sextant is to read and be accurate to one minute of arc. The principal departures from ordinary practice in sextant manufacture are (i) making the arc separately from the limb and subsequent assembly with sufficient accuracy as regards centring, (ii) metallic mirrors, (iii) micrometer reading to replace the vernier, (iv) abolition of the rising piece. AUTHOR.

631. *The Aerial Sextants Designed by the Royal Aircraft Establishment.* **L. B. Booth.** (Optical Convention, Proc. Part II. pp. 720–725; Disc., 725–728, 1926.)—Reference is made to the difficulties of position finding in the air, for which the accuracy need not be so extreme as for marine work. A description is given of two types of bubble sextants developed at the R.A.F., in which a special design of bubble system is used. AUTHOR.

632. *Review of Lens Theory.* **T. Smith.** (Optical Convention, Proc. Part II. pp. 740–758; Disc., 758, 1926.)—Two lines of development of the theory of lenses corresponding to two theories of light are traced. The influence of the theory of light on the principles to be used in correcting lenses is illustrated. A system for tracing rays with the aid of calculating machines is outlined, and reference is made to recent work on aberrations and on methods of measuring aberrations. AUTHOR.

633. *Theory of the Reproduction of Self-Luminous Points, Lines and Planes by an Optical System.* **A. Buxton.** (Optical Convention, Proc. Part II. pp. 759–774; Disc., 774–775, 1926.)—The theory of the reproduction of luminous points, lines and planes is fundamental to the determination of the real nature of the performance of an optical system. The geometrical reproduction of object into image is not correctly borne out point for point and line for line, owing to certain defects. The effect of the first of these, diffraction, is considered at length in the case of a circular aperture. The effects of inherent defects of spherical surfaces are outlined under the headings of malfocus, spherical aberration, chromatic aberration, coma and astigmatism, with a few combinations of the two first-named. The method adopted, whether dealing with self-luminous point, line or plane sources, has been to investigate the distribution of the light in the images. For the point source, the image investigated by Airy in 1834 has been taken as the standard, all images of point sources under varying conditions being compared with it. The greater part of the work has been concerned with the calculation of the intensity of the light in these images, and with obtaining expressions to denote it. An attempt has been made to indicate the modifications of accepted limits of resolution, and also the lines of any future extension of the work. AUTHOR.

634. *Diffraction Patterns Associated with a Symmetrical Optical System.* **G. C. Steward.** (Optical Convention, Proc. Part II. pp. 776–799, 1926.)—The image of a luminous point, given by a symmetrical optical system, will not itself be a point; and this will follow both from the nature of light and also from the necessary "imperfections" of the system. A part only of the incident wave will pass through the system, and diffraction phenomena will appear; in addition, the emergent wave will not be a portion of a sphere, but will be distorted by the geometrical aberrations of the system. In the following paper is given some account of the modifications produced in the ideal diffraction pattern by the presence of these geometrical aberrations. To this end the history of investigations relating to the purely geometrical aspect of the problem is indicated briefly; these extend over many years; and then the application to the diffraction phenomena is considered. For the most part, these investigations are of recent date. Detailed mathematical investigations and the expansions of the integral expression obtained are not given in full; for these reference may be made to the papers by the author quoted in the text. [See Abstract 2813 (1926).] Here the results only are given, combined with a general sketch of the methods involved. AUTHOR.

635. *Effect of a Thin Astigmatic Lens upon an Astigmatic Pencil of Light.* **G. F. C. Searle.** (Optical Convention, Proc. Part II. pp. 813–824, 1926.)—The modification which a beam of light undergoes in passing through a thin astigmatic lens when the chief ray of the beam coincides with the axis of the lens is considered in text-books. In terms of the data of the incident beam and of the lens, the theory gives the positions of the two points—say, P_1 and P_2—in which the focal lines of the emergent beam cut the chief ray and also gives the mutually perpendicular directions of the two focal lines. As generally presented, the theory does not show which of the two directions is that of the focal line through P_1. If the circumstances be such that the constants of the incident beam have to be determined from observations made on the emergent beam, a further difficulty of interpretation occurs. Similar difficulties have appeared in experiments on focal lines formed by a zone plate and on the focal lines formed when an astigmatic beam falls on a diffraction grating. The paper sets out the theory afresh and indicates the points of difficulty. It contains a contribution by G. T. Bennett of some simple graphical methods of treating the problems. In the experimental work, the incident beam is of constant form and is turned about the chief ray as axis. The positions and directions of the focal lines of the emergent beam were observed by C. F. Sharman, and the measurements are compared with the results given by the theory in terms of the data of the incident beam and of the astigmatic lens. AUTHOR.

636. *Cardinal Points of a Thick Lens for Rays which have Suffered Two Internal Reflections.* **G. F. C. Searle.** (Optical Convention, Proc. Part II. pp. 825–829, 1926.)—In addition to the ordinary image produced when a luminous point is placed on or near the axis of a lens with spherical faces, a second and comparatively weak image is formed by rays which, in their passage through the lens, have suffered one reflection at each of the two surfaces of the lens. This image is known as the " flare-spot " image. The two focal lengths and the positions of the principal or unit points are calculated for the flare spot system of rays when a thick lens of index μ is in contact with media of indices μ_1, μ_2. Measurements are given of the focal length and determination of the positions of the principal points for flare-spot rays in the case of a thick lens in air; the thickness was 2·45 cm. The results are in close agreement with theory. AUTHOR.

637. *Effects of Primary Spherical Aberration on Optical Images.* **Miss H. G. Conrady.** (Optical Convention, Proc. Part II. pp. 830–836; Disc., 837–838, 1926.)—An attempt has been made to summarise existing knowledge, theoretical and experimental, of the behaviour of optical images in the presence of primary spherical aberration. A short description is given of the theoretically predicted effects of spherical aberration on the location and quality of optical images. This is followed by a brief account of experimental work carried out to ascertain the actual effects of both large and small amounts of aberration on the intensity, location, size and depth of focus of images. [See also Abstract 979 (1926).] AUTHOR.

638. *The Hartmann Test.* **R. Kingslake.** (Optical Convention, Proc. Part II. pp. 839–847; Disc., 847–848, 1926.)—The principle of the Hartmann test is described and methods are given by which the aberration found may be expressed in the several forms used in theoretical investigations. Recent work, including the application of the test to microscopes and to concave mirrors and the one-plate method is discussed, together with the extension of the method to non-axial parts of the field for the determination of coma and astigmatism. Viewing the plates stereoscopically is mentioned as a rapid—but not very precise—method of finding the character of the spherical corrections. AUTHOR.

639. *The Taylor-Hobson F/2·5 Anastigmat Lens.* **H. W. Lee.** (Optical Convention, Proc. Part II. pp. 851–860, 1926.)—The construction of the lens is explained and the aberrations found by trigonometrical computation are presented in a manner uniform with that adopted in von Rohr's *Theorie u. Geschichte des Photographischen Objektivs*, and analysed. Some suggestions are made with regard to the requirements of cameras for use with large aperture lenses. AUTHOR.

640. *The Telephoto Lens.* **L. B. Booth.** (Optical Convention, Proc. Part II. pp. 861–867; Disc., 878, 1926.)—Reference is made to the state of affairs in this country immediately before the war as regards telephoto lenses. The method by which the first large aperture telephoto lenses were produced is described and also how the defects still present were gradually overcome whilst still retaining the simple form of two pairs of cemented lenses. AUTHOR.

641. *Development of the Telephotographic Objective.* **H. W. Lee.** (Optical Convention, Proc. Part II. pp. 869–877; Disc., 877, 1926.)—Three periods mark the development of the telephotographic objective since its introduction to general use in 1891: (1) The period of the variable magnification type; (2) the introduction of the fixed focus type; and (3) the development of the anastigmat fixed focus type. The progress of invention from 1891 to the present day is described and the aberrations of some typical lenses are presented in a manner uniform with that adopted in von Rohr's *Theorie u. Geschichte des Photographischen Objektivs*. AUTHOR.

642. *A Lens for Whole-Sky Photography.* **R. Hill.** (Optical Convention, Proc. Part II. pp. 878–883, 1926.)—The projection of 180° on to a flat plate involves distortion. The best method is by the stereographic projection. By discussing the properties of a simple lens system, it is shown that equidistant projection can be obtained and applied to photography. A simple property of the lens system allows the projection to be transformed subsequently into either a stereographic representation or a series of normal photographs. A brief account is given of the methods of correction available in a system of two simple lenses enclosing an air space containing a stop and including an angle of 180°. AUTHOR.

643. *An Improved Cinematograph Projector.* **R. J. Trump.** (Optical Convention, Proc. Part II. pp. 899–908, 1926.)—An epicyclic gear drives the Maltese cross and intermittent sprocket, thus increasing operation speed. The motion of the circular pin disc is studied under the ideal condition of tangential entry into the slots, and it is shown that over its operative portion the path of the pin in this device is practically a quadrant of a circle; but the picture change is concluded in one-twelfth of a cycle, enabling the shutter blades to be reduced in size, with a gain of nearly 50 % in the light; or, while retaining much of this advantage, a fourth shutter blade may be added, raising the flicker frequency to provide an adequate margin for extreme cases. Retention of tangential entry enables the film to withstand increased operation speed by eliminating jerk. AUTHOR.

644. *Measurement of Refractive Indices and Description of a Large Spectrometer of the Auto-Collimating Type.* **J. W. Hasselkus.** (Optical Convention, Proc. Part II. pp. 925–934; Disc., 934–936, 1926.)—For the purpose of a more accurate and complete determination of refractive indices of optical glasses throughout the visible spectrum, the inclusion of new spectrum lines and the abolition of some lines hitherto used are advocated. A large autocollimating spectrometer with 18-in. circle is described, and the refractive indices of quartz determined by this instrument are compared with the data given in Glazebrook's *Dictionary of Applied Physics.* AUTHOR.

645. *Some Principles of Spectrometer Design.* **J. Guild** and **G. W. Watts.** (Optical Convention, Proc. Part II. pp. 937–950; Disc., 950, 1926.)—This paper is in two parts, in the first of which are discussed some essential principles of design which experience has shown to be of fundamental importance in spectrometers intended for the highest class of goniometric work. In the second part a detailed description is given, with drawings, of an instrument built for the National Physical Laboratory by E. R. Watts & Son, in which these principles have been incorporated. AUTHORS.

646. *Method of Mounting a Concave Grating.* **D. M. Smith.** (Optical Convention, Proc. Part II. pp. 951–955; Disc., 955–956, 1926.)—A method of increasing the linear dispersion by mounting a concave grating with the slit inside the Rowland circle is described. Curves showing the positions of the diffracted images for various positions of the slit have been constructed. Numerical cases are given, when the grating is mounted so as to give a normal spectrum and when mounted in the Littrow manner, and a general formula for the dispersion applied to these particular cases. AUTHOR.

647. *Recent Advances in the Optical Design of Spectrographs.* **J. W. Perry.** (Optical Convention, Proc. Part II. pp. 957–964, 1926.)—Conditions characterising the design of spectrograph systems are established and discussed, and types of camera objectives recently introduced are detailed. A general formula is deduced for the curvature of spectrum lines resulting from prismatic refraction. AUTHOR.

648. *Graphical Methods Applied to the Design of Optical Systems.* **J. H. Dowell.** (Optical Convention, Proc. Part II. pp. 965–981; Disc., 981, 1926.)—A graphical method applied to spectrograph design in which a plane wave-front is traced through the prism systems by a development of Huyghens' construction. Ray tracing through prisms is similarly dealt with. The method is then extended to apply also to lens systems. A system of drawing is also described in which vertical and horizontal ordinates of a drawing are made to different scales; and this system is applied by way of example to the design of the optical train of a polarimeter. AUTHOR.

649. *Theory and Use of Transmission and Reflection Echelon Gratings.* **W. E. Williams.** (Optical Convention, Proc. Part II. pp. 982–990, 1926.)—The theory of the tilted echelon grating is obtained very simply by treating it as an ordinary diffraction grating and applying the usual diffraction grating formulæ to it. Explanations are given of (*a*) the varying position of a spectral line as the tilt is altered; (*b*) the presence of the fainter orders visible in the "single order" position. A possible source of error in comparing the intensities of two close lines by varying the tilt of the grating is discussed. The theory of the reflection echelon is developed on the same lines, and the relative advantages of the two types considered. The reflecting instrument need only be a quarter of the length of a transmission echelon of equal resolving power, while the difficulties of mechanical mounting, temperature control, absorption of light by the material, etc., can either be minimised or eliminated altogether in the reflection echelon. A comparison table showing the relative merits of a reflecting echelon, and a Fabry and Perot interferometer, is given. AUTHOR.

650. *A New Measuring Micrometer.* **J. H. Dowell.** (Optical Convention, Proc. Part II. pp. 991–998; Disc., 998–999, 1926.)—A new micrometer measuring up to 6 in. is described, and the theoretical considerations controlling its design are discussed. The main features are a carriage with geometric bearings, which can be released from the nut to line up the specimen, an enclosed screw and slide, and a microscope of geometric design adapted to take a wide range of objectives. AUTHOR.

651. *Eyepiece and Interchangeable Nosepiece for "Centring" and "Squaring on" Microscope Objectives.* **A. F. C. Pollard.** (Optical Convention, Proc. Part II. pp. 1000–1009; Disc., 1009–1011, 1926.)—The need of mechanical facilities for adjusting and fixing the optical axes of the objectives and condensers of microscopes in line with that of the eyepieces and parallel to the coarse adjustment slide is briefly discussed. A special eyepiece is described, by means of which the series of images of a luminous ring-shaped graticule, reflected from the surfaces of the elements of an optical component, can be magnified and observed. The array of images, as first used by Wollaston in 1821, affords a means for accurately setting the optical axis of a component into coincidence with the true optical axis of the instrument, parallel to that of the slide. A "safety" changer designed upon kinematical principles is described, which enables the objective to be adjusted and fixed in any desired position. The manufacture of the changer is briefly discussed. AUTHOR.

652. *Some Recent Advances in the Manufacture and Use of the Microscope.* **C. Beck.** (Optical Convention, Proc. Part II. pp. 1012–1031, 1926.)

653. *Universal Lens Interferometer.* **J. H. Dowell.** (Optical Convention, Proc. Part II. pp. 1032–1049; Disc., 1049–1051, 1926.)—A lens interferometer is described with means for testing or correcting camera lenses, process lenses, telephoto lenses, and telescopic systems generally for axial or oblique rays. Means are also provided which enable lenses to be tested or corrected where the focus would otherwise be beyond the range of the instrument, such as telescope object glasses of long focal length. AUTHOR.

654. *Spectral Filters.* **K. S. Gibson.** (Optical Soc. America, J. and Rev. Sci. Inst. 13. pp. 267–280, Sept., 1926.)—This is a compilation, with bibliography, of data relating to filters for the ultra-violet, visible and infra-red regions. As a rule only those filters are considered which have a relatively sharp transition between the regions of free transmission and sharp absorption. F. S.

655. *Absorption of Linear and Circularly Polarised Light.* **E. V. Angerer** and **G. Joos.** (Phys. Zeits. 27. pp. 579–584, Sept. 15, 1926.)—The authors first discuss the theoretical considerations under which it is possible for the absorption of light in a gas to depend upon the degree of polarisation in the incident light. Particulars are given of the apparatus employed in testing the results for Rb vapour. A high degree of vacuum was employed and gaseous collisions were thus minimised, while the effects of the earth's magnetic field were compensated. A Rowland concave grating was used to separate the Rb red absorption lines (7947·6 and 7800·2 Å.), the apparatus being kept at a constant temperature and a filter used to remove extraneous wave-lengths. Within the limits of error the ratio of the intensities for the Rb doublet was independent of the state of polarisation. Even at 18° C. the Rb line was recognisable, and since at 18° C. the vapour pressure is 7×10^{-8} mm. while the radiating layer was 1 metre long, it is thus possible to detect 3×10^{-11} gm. of Rb vapour. The sensitivity of the absorption spectroscope, therefore, approaches for a monatomic gas that of radioactive investigations, or the sense of smell. R. S. R.

656. *Excitation of Polarised Light by Electron Impact.* **H. W. B. Skinner.** (Roy. Soc., Proc. 112. pp. 642–660, Oct. 1, 1926.)—Polarisation measurements were made on the light emitted from an electron tube capable of producing an intense unidirectional stream of electrons of slow speed used for the excitation of the mercury spectrum. At 20 volts many of the Hg lines are partially plane-polarised, most with the direction of the maximum electric vector parallel to the stream, but some (*e.g.*, $\lambda 2537$) in the perpendicular direction. For $\lambda 5770$ and 5791 the polarisation parallel to the stream decreases rapidly as the speed of the electrons increases. Application of a magnetic field

(40 gauss) in the direction of the stream has no influence on the polarisation, but a field of 2 gauss applied perpendicular to the stream causes (*a*) depolarisation and (*b*) rotation of the plane of polarisation. Each of these two effects leads to a determination of the mean life of the atom in the excited state, and the values are concordant. Nine pages are devoted to a careful discussion of the results. W. H. Ge.

657. *Polarisation of Dissonant Canal-Ray Light.* **E. Rupp.** (Ann. d. Physik, 81. 6. pp. 615–631, Oct. 26, 1926.)—The polarisation relation of the glowing atoms of hydrogen, helium and lithium in dependence on the angle of vision is measured photometrically. That portion of the dissonant canal-ray light polarised parallel to the canal ray is more intensive than that polarised at right angles to it when viewed at right angles to it. The degree of polarisation is greatest for hydrogen, somewhat smaller for the line $2p$–$3d$ of lithium and the series $2p$–md of orthohelium, $2P$–mD of parhelium. For the series lines $1 \cdot 5s$–$2p$, $2p$–ms of lithium and $2p$–$4s$, 2S–3P, 2P–4S of helium the polarisation is very small. The polarisation is considered to be produced by collisions of the quick-moving atoms with free electrons or with atoms at rest in the canal of the tube. A. E. G.

658. *Molecular Theory of Magnetic Rotatory Polarisation. Calculation of Verdet's Constant.* **R. de Mallemann.** (J. de Physique et le Radium, 7. pp. 295–315, Oct., 1926.)—Molecular theory connects structure with magnetic rotation by an invariant combination of fundamental parameters from which refraction, etc., are interpreted. The author now establishes such a correlation that the molecular parameters are eliminated when account only is taken of the average anisotropy of the molecule, and derives a simple expression connecting the Verdet constant, refractive index and Kerr constant. The Verdet constants are then calculated for a number of substances, and, when the molecule is considered as a system of atoms individually isotropic, found expressible as functions of the atomic refractions, leading to an additive law similar to that of Perkin. The theoretically derived law of dispersion agrees with the experimental results in the visible spectrum, and the ratio of the magnetic rotatory and electric birefringence dispersions is established as equal to the corresponding ratio of the wave-lengths. Negative magnetic rotations and anomalous dispersions are shown to be connected with the presence of one or more paramagnetic atoms, creating a local negative field. **Errata** (*ibid.*, p. 368, Dec., 1926). [Abstracts 994 and 2584 (1926) should also be consulted.] H. H. Ho.

659. *Fraunhofer's Work and its Present-Day Significance.* **M. v. Rohr.** (Optical Soc., Trans. 27. 5. pp. 277–292 ; Disc., 292–294, 1925–1926.)—The hundredth anniversary of the death of Fraunhofer has presented a fitting opportunity for giving a more accurate account of the advances he made in optical work than has hitherto been possible. This account is based on his own papers, contemporaneous descriptions, and recent detailed measurements of his telescopes. Since various old English achromatic telescopes were also available for measurement, it has been possible to compare the results of the London and Benediktbeurn-Munich products. Whilst the English opticians—in particular J. Ramsden and the firm of Dollond—are renowned owing to their successfully carrying out experimental methods which enabled them reasonably to correct for spherical aberration, Fraunhofer obtained markedly superior results by the application of scientific methods of measurement, testing, computation, and glass-making. A description of the development of his work in Vienna is given, and attention is drawn to his three main achievements as indicated by M. Faraday and more fully outlined by E. Abbe. **Author.**

660. *The Light Transmitted and Reflected by a Pile of Plates.* **T. Smith.** (Optical Soc., Trans. 27. 5. pp. 317–323; Disc., 323, 1925–1926.)—The properties of a series of media or of a pile of plates which absorb and scatter light, and the interfaces of which may also absorb and scatter as well as transmit and reflect light, are investigated without assuming that any of these factors are independent of the direction in which the light travels. It is shown that in general (*a*) the ratio of the transmissive factors of a pile of plates in the two directions is independent of all reflective properties of the surfaces and of the order in which the plates are arranged; (*b*) the transmissive factors in the two directions are equal if the individual transmissive and absorptive factors are the same for the two beams; (*c*) the ratios of the light transmitted without reflection to the total light transmitted are equal in both directions; (*d*) the reflective properties of the pile depend upon all the factors of the system, and the ratio of the two reflective factors is not independent of the order in which the plates are placed; and in non-absorbing systems (*e*) the sum of the intensities of the reflected and transmitted beams is equal to the intensity of the incident beam, and the ratio of the intensity of the reflected to that of the transmitted beam is equal to the sum of the corresponding ratios for the component plates or surfaces of the pile. Such a pile evidently forms an exception to the rule (*d*) that the reflective coefficients depend on the order in which the plates are arranged. Formulæ for computing the transmissive and reflective factors for the pile are given. **Author.**

661. *The Immutability of Transmissive Factors with Reversal of Light.* **D. S. Perfect.** (Optical Soc., Trans. 27. 5. p. 324, 1925–1926.)—Direct experimental evidence has been obtained that the transmissive factor of the surface separating two media is unaltered if the direction in which the light travels is reversed [see the preceding Abstract]. **Author.**

662. *Theory of Diffraction at the Edge of a Black Screen.* **A. Rubinowicz.** (Ann. d. Physik, 81. 2. pp. 140–154, Sept. 8, 1926.)—A reply to criticisms of the author's previous paper [see Abstract 2475 (1924)] by F. Kottler [see Abstract 523 (1925)]. J. W. T. W.

663. *Theory of Diffraction at the Edge of a Black Screen.* **F. Kottler.** (Ann. d. Physik, 81. 4. pp. 373–390, Oct. 8, 1926.)—A reply to criticisms of the author's previous work [see Abstracts 1547, 2398 (1923), and 523 (1925)] by W. v. Ignatowsky [see Abstract 78 (1926)]. J. W. T. W.

664. *Diffraction of Light by Spherical Obstacles.* **C. V. Raman** and **K. S. Krishnan.** (Phys. Soc., Proc. 38. pp. 350–353, Aug., 1926.)—The diffraction of light inside the shadow, thrown by a small source of light of a sphere and a circular disc of the same diameter, was studied, with special reference to the relative intensities of the central bright spots.

With the source at about 2 metres from the obstacles, with a $\frac{1}{4}$-in. polished steel ball, the bright spot could be detected visually up to 3 cm. behind the obstacle, while with a steel disc of the same diameter, with the edges perfectly sharp, smooth and circular, the spot could be traced up to 2 cm. The relative intensities of the two spots were studied at different distances behind the obstacles, qualitatively by photography and quantitatively by visual photometry. At small distances behind the obstacles the spot inside the shadow of the sphere is much feebler than the disc-spot, however approximating to the latter as we reach farther back from the obstacles, but even at 100 cm. remaining appreciably feebler. A general explanation is suggested. AUTHORS.

665. *Diffraction Grating Images and Interference Figure Images as Formed by a Microscope Objective.* **L. V. Foster.** (Optical Soc. America, J. and Rev. Sci. Inst. 13. pp. 291–296, Sept., 1926.)—The experiments of Driesen [see Abstract 465 (1924)] have been repeated, and it was found possible to photograph the Wiesel stripes under one set of conditions where Driesen failed. Seven of the photographs are reproduced. W. H. GE.

666. *Refraction and Dispersion of Gaseous Carbon Disulphide.* **H. Lowery.** (Phys. Soc., Proc. 38. pp. 470–472, Aug., 1926.)—The refractive index of gaseous carbon disulphide was found to be as follows :—

$$\nu = 6708,\ 6438,\ 5791,\ 5770,\ 5461,\ 5209,\ 5086,\ 4800.$$
$$(\mu - 1) \times 10^6 = 1436,\ 1443,\ 1463,\ 1464,\ 1476,\ 1488,\ 1495,\ 1514.$$

These results can be expressed accurately in the equation

$$\mu - 1 = \frac{5\cdot3530 \times 10^{27}}{3926\cdot6 \times 10^{27} - n^2},$$

where the frequency $n = v/\lambda$, and $v = 3 \times 10^{10}$ cm. per sec. T. M. L.

667. *Dispersion of Light by Small Spheres.* **H. Blumer.** (Zeits. f. Physik, 39. 2–3. pp. 195–214, 1926.)—On the basis of earlier work the author has calculated the distribution of intensity of scattered light for small dielectric spheres of different refractive indices and diameters. [See Abstract 1850 (1925).] In the present paper the author calculates the colour picture produced by these small spheres for all directions of the scattered light and for different wave-lengths. The wave-lengths used were violet (393$\mu\mu$), green (524$\mu\mu$), red (629$\mu\mu$) and infra-red (786$\mu\mu$). The calculations were made for spheres whose refractive index is 1·25, and of diameters 50, 100, 200, 500 and 1000$\mu\mu$. The results are set out in tabular form and also graphically. These calculations can hold as a basis for judging the colour of dispersive media such as colloidal solutions or atmospheric turbidity. In view of the application to phenomena at twilight, the ratio of the intensities of red and green light has been found and its dependence on the size of the sphere and the angle of scattering set out in tables and represented graphically. It is shown that with increasing diameter of the sphere several maxima and minima occur, and thus no general law can be given for the ratio of intensities for different diameters of the spheres. R. S. R.

668. *Dispersion and Molecular Refraction of Alkali and Hydrogen Halogenides.* **K. L. Wolf.** (Ann. d. Physik, 81. 6. pp. 637–648, Oct. 26, 1926.)—As a result of measurements of dispersion, tables have been set out giving the limiting wave-length, centre of continuous absorption, resonance line and the molecular refraction for the four halogens F, Cl, Br and I, in combination with each of the five alkalies Li, Na, K, Rb and Cs. From these results it is concluded that for the halogen ions the probable transference to a higher orbit (resonance line) is increased through the internal structure of the lattice at the expense of the complete separation of an electron, and increases further with increasing atomic weight. Using new atomic numbers and a more exact estimate of the resonance line, values are calculated for the molecular refraction of alkali halides and these compared with observed values. An improved agreement is now obtained between the two sets of figures. The share of the kations in molecular refraction could be obtained from Mohler's discussion of critical electronic velocities. This leads to a different determination from Mohler's, corroborates the values estimated formerly for the limiting series of alkali spark spectra, and also gives rise to no uncertainty for the atomic numbers. R. S. R.

669. *The Selective Dispersion of Mercury Vapour at the λ2536 Absorption Line.* **F. E. Klingaman.** (Phys. Rev. 28. pp. 665–671, Oct., 1926.)—By means of a Rayleigh's gas refractometer, measurements were made on the interference fringes in seven iron lines extending about 3 Å.U. on both sides of the mercury absorption line at λ2536·7. The mercury vapour pressures used ranged from 0·0015 to 0·113 mm. of mercury. Shifts of fringes for the line closest to λ2536·7 were found to be proportional to the density of the vapour, while farther from the absorption line the displacements of the fringes increased less rapidly than the density of the vapour. This is probably due to the increasing width of the absorption line and not to complex mercury molecules as has been previously suggested. The molecular refractive indices for the wave-lengths 2536·9, 2538·4, and 2535·6 were found to be respectively 1·068, 1·006, and 0·988. Selective dispersion in the vicinity of λ2536·7 was demonstrated by means of crossed prisms. Data by Cuthbertson and Metcalfe on refractive indices of mercury vapour indicate an absorption band somewhere between λ6560 and λ6900. Since no evidence of selective dispersion was found in this region, it was concluded that their value for the index at λ6560 is about 3 % low. AUTHOR.

670. *Scattering of Light by Small Spheres.* **H. Blumer.** (Zeits. f. Physik, 38. 11–12. pp. 920–947, 1926.)—The author gives a wide critical review of all the older and more recent literature on this subject and the functions obtained to express the results, while several tables and graphs illustrate these values. The intensity of the scattered light obtained from the pure diffraction theory and the laws of reflection and refraction was compared with that resulting from the use of Maxwell's equations for the electromagnetic field. The former gives an additional term which is independent of the angle of scattering and of the size of the spheres, and an attempt is made to explain it. For opaque spheres a comparison of the intensity calculated from the theory for the diffusive scattering of light with that from the electromagnetic theory shows no material connection in consequence of the different characteristics of the scattering functions. R. S. R.

671. *The Scattering of Light by Gaseous Mixtures at High Pressures.* **L. A. Ramdas.** (Phys. Rev. 28. pp. 1030–1033, Nov., 1926.)—The intensity of light transversely scattered by pure oxygen, carbon dioxide and their mixtures in various proportions for pressures ranging from 20 to 120 atmos. at 32° C., has been measured in terms of the scattering by liquid ethyl alcohol. Some polarisation measurements have also been made for pure oxygen and unsaturated carbon dioxide. The intensity for pure oxygen is proportional to the pressure, whereas for mixtures of increasing percentage of carbon dioxide the intensity-pressure curves tend to become more and more similar to the curve for pure carbon dioxide, for which the intensity increases much more rapidly than the pressure. At pressures greater than a few atmospheres the intensity of scattering ceases to be a linear function of the percentage volume of CO_2 in the mixture. AUTHOR.

672. *The Validity of Talbot's Law for the Photographic Plate.* **E. A. Baker.** (Optical Convention, Proc. Part I. pp. 238–242; Disc., 242–244, 1926.)—The action of intermittent light on a photographic plate may be represented approximately by a law similar to that of Schwarzschild for continuous light, *viz.* $f(D) = It^{\pi}$, where D is the density, I the illumination, and t the duration of actual exposure to light. If the sector is revolved once only, π is equal to Schwarzschild's index p; but if Talbot's law applies, π will become unity for sufficiently high sector speeds. The values of π are given for the special case of an 180° sector and total exposures of the order of one minute, under circumstances for which the range of p was 0·71 to 1·06; of wave-length, 0·61μ to 0·36μ; and of plate speed, 5 to 700 H. and D. The results show that the deviation of π from unity for speeds giving over 60 flashes per sec is less than 1 %, but that for 800 flashes per sec. the deviation from unity may still be appreciable. AUTHOR.

673. *Future of Photographic Astronomical Instruments.* **H. D. Taylor.** (Optical Convention, Proc. Part II. pp. 584–591; Disc., 591–593, 1926.)—In view of the all-important and still-increasing functions of photography in astronomical science, enabling measurements of positions and relative movements of stars, etc., to be obtained, it is important to consider the merits of reflecting and refracting instruments used for photographic purposes; and then, on realising the fact that the one type is as necessary as the other, each on its own lines, it can be shown that, while the reflecting power of silver on glass cannot be substantially improved, there is yet a possibility of very considerably increasing the transparency to violet and ultra-violet actinic rays of certain refracting photographic telescopes by embodying in their construction certain types of optical glasses now available. The writer then estimates the gain in rapidity of action or shortening of exposure that may be expected to be attained by using the new glasses. He also points out the immense practical importance of shortening exposures in photographic astronomy, due to the fact that the utmost possible time for which a photographic instrument can be used, even if situated in an ideal climate, is only too limited, and may be further curtailed by cloudy or bad weather. Therefore every gain in rapidity of action of such instruments implies a larger crop of photographic records on which astronomical research can be based. Further suggestions are made for much increasing the rapidity of large reflecting telescopes when photographing nebulæ of faint luminosity by a simple optical addition. AUTHOR.

674. *Air Photography Apparatus.* **H. B. Stringer.** (Optical Convention, Proc. Part II. pp. 729–739, 1926.)—The author, after discussing the chief requirements to be fulfilled in a satisfactory aerial camera, whether for military or for surveying use, describes the type F.8 aerial camera in detail, and makes suggestions for future designs. AUTHOR.

675. *Rectification of Aerial Survey Photographs.* **M. N. MacLeod.** (Optical Convention, Proc. Part II. pp. 653–661; Disc., 662, 1926.)—In aerial surveying there is an opening for a cheaper and simpler technique than that of the automatic plotting machine. The author discusses the geometrical and mathematical principles underlying a projection method of rectification. It is first necessary to determine the tilt of the camera at the instant when any given photograph was taken, and a simple form of apparatus for doing this is described and illustrated. This apparatus gives the height and tilt, and it is then possible, by a simple form of projection apparatus, to rectify th ephotograph, *i.e.*, to obtain a map such as would have been produced on the plate if the axis of the camera had been truly vertical. The method is first described with reference to a survey of flat ground, but the application of the method to hilly country is also given, and the use of the "camera plastica" for the determination of ground heights is described. J. W. T. W.

676. *Some New Applications of Selenium.* **E. E. F. d'Albe** and **E. O. Symonds.** (Optical Convention, Proc. Part II. pp. 884–893, 1926.)—This paper discusses and describes a number of new optical methods, based upon the photoelectric properties of selenium. Among these are the use of selenium for astronomical purposes, for photometry, for the determination of extinction coefficients of glasses, for infra-red, visible, and ultra-violet spectroscopy, and for the mechanical counting of interference fringes. For the last of these, a valve amplifying apparatus is described and exhibited, suitable for registering the passage of Fabry-Pérot interference fringes on a tape. It employs selenium detectors 1 $mm.^2$ in area. The valve amplifier is designed to eliminate all accidental variations and disturbances, and is used to work a Creed relay and undulator. AUTHORS.

677. *Registering Microphotometer with a Photoelectric Cell.* **E. Bouty.** (Rev. d'Optique, 5. pp. 404–420, Oct., 1926.)—Illustrated description of a new registering microphotometer, the distinguishing feature of which is a resistance amplifier with one lamp, enabling the current of the cell to be amplified steadily and without deformation. It is shown in detail that by taking very simple precautions this device may be made to yield perfectly coherent and comparable results. It may be applied to measuring the absolute value of densities. The amplification renders it very adaptable and capable of covering a wide range of density, suitable regulation making it very sensitive either to slight or to very strong densities. It has been utilised in spectroscopic researches (comparison of radiative energies, determination of coefficients of absorption), and is adapted to the study of minute details and the exact determination of the position of maximum and minimum intensities on photographic plates of spectra. [See Abstract 1766 (1924).] E. F.

678. *Blackening of Photographic Emulsions by Low-Speed Electrons.* **K. Cole.** (Phys. Rev. 28. pp. 781–792, Oct., 1926.)—New type of electron spectrograph.—Electrons from an oxide-coated filament are accelerated to a cylindrical anode, coaxial with the filament, having a narrow slit for one of its elements. The whole system is placed in a uniform magnetic field parallel to the filament. Those electrons which pass through the slit focus in the plane normal to that containing the filament and the slit. 22-volt electrons have been focussed sharply. An extremely accurate direct determination of e/m should be possible with this arrangement.

The results indicate that the blackening of photographic emulsions by low-speed electrons is due to radiation produced by electron impact on the surface of the emulsion and is a discontinuous function of the electron speed. For electrons with speeds below 100 volts, the blackening apparently depends upon the grain size and gelatine thickness of the emulsion. A thin film of fluorescent lubricating oil on the emulsion greatly increases its sensitivity. Schumann plates have an enormous sensitivity. AUTHOR.

679. *Doppler Effect and Fluorescence in Mixed Vapours.* **F. Rasetti.** (Accad. Lincei, Atti, 4. pp. 133–137, Aug., 1926.)—In a mixture of mercury and sodium vapours illuminated by λ2537, the D line is emitted. This is due to the collision of an excited mercury atom (4·9 volts) with a sodium atom with the consequent excitation of the sodium atom corresponding to emission of the D line (2·1 volts), while the sodium atom moves with a velocity given by the excess energy (2·8 volts). Thus a broadening of the D line due to the Doppler effect is to be expected. The effect has been looked for and is found to agree with theory within the limits of error. The apparatus is described. A. Wh.

680. *Excitation of Phosphorescence by Moderately Fast Kathode Rays.* **R. Stadler.** (Ann. d. Physik, 80. 8. pp. 741–778, Aug. 21, 1926.)—While no new bands are excited by kathode rays in comparison with light, the relative intensity of the bands is different. The temperature behaviour of the "long duration" and of the "hot" bands is the same. On the other hand, "cold" bands produced both with kathode rays and with short wave light appeared to be stored up in an upper "M" state. It is necessary to suppose that for this phenomenon the electrons ejected from the impurity atoms must have considerable velocity. It is concluded that "d" centres whose upper "M" state lies at not too high a temperature must be considered as not possessing excitability in this state for long wave light. The "M" light of all bands is brought out at all temperatures by kathode rays and disappears nearly always at about red heat. Quantitative investigation on the light-sum produced by kathode rays in the case of CaS, Bi show that this is smaller than with photo excitation. No measurable rise of temperature exists by which the deficiency in the kathode light-sum can be explained. The extinction of the light-sum with kathode rays does not exist in the output, but is due to a cancelling process (Tilgung). The "u" process (ultra-violet emission) discovered by Lenard was also investigated with kathode rays and short light waves and found to be identical in both cases. The existence of this "u" process and the corresponding "Tilgung" accounts for all the facts of kathode excitation. (1) The maximum excitation can never be reached, since at the conclusion of excitation a part of the centres are already decayed; (2) the light sum ratio K_K/L_λ (referring to kathodo and photo excitation) must, during excitation, be independent of temperature, since the secondary radiation, the principal cause of the "Tilgung," is independent of temperature. The composition and velocities of the secondary radiation can be different according to the method of preparation of the substance, which explains the variation of L_K/L_λ with different preparations. At higher temperatures this ratio approaches unity with decreasing wave-length. J. E.

681. *Fluorescence produced by Short Ultra-Violet Waves.* **O. Oldenberg.** (Zeits. f. Physik, 38. 4–5. pp. 370–377, 1926.)—Gives an account of an attempt to excite fluorescence in nitrogen and hydrogen by the use of very short ultra-violet light. In the case of hydrogen the exciting rays must have a wave-length less than 1100 Å.E., and no crystal is known which is transparent to these short waves, hence the source of light must be inside the fluorescence tube. The fluorescent beam was observed through a small slit in the side of a copper cage. A strong magnetic field was applied at right angles to the tube. For the analysis of the beam a prism apparatus and a fluorspar vacuum spectrograph were employed. The fluorescent spectrum of nitrogen was found to consist of bands. No nitrogen lines were seen and no metal lines. Stronger fluorescence was obtained with oxygen. With hydrogen the fluorescence is exceedingly weak, and, owing to impurity, shows the nitrogen bands. No trace of fluorescence was observed in the Schumann region. The Balmer lines H_β and H_δ were very clear. The work of Blackett and Franck is referred to. The author concludes that at first adsorption causes only excitation of the molecule and later, as the result of a collision, disintegration into a normal and an excited atom. T. B.

682. *Accompaniments of Zeeman Effects in Weak Magnetic Fields. The Effect of Added Gases.* **W. Schütz.** (Zeits. f. Physik, 38. 11–12. pp. 864–886, 1926.)—With observations on transverse double refraction and the orientation of the electric vector of the irradiated light it is not possible with the known level schemes to explain the phenomena of dispersion as it is possible for the phenomena of resonance. The marked influence of added gases on the Cotton effect in Na vapour leads to a method for estimating the effect of gases on the damping of spectral lines at low pressures; data are given for He, N_2 and A. Investigation of the Righi effect gives the first experimental method of recognising the Zeeman effect in fields of less than 1 gauss. The dependence of this effect in weak fields upon vapour density and gas pressure leads to a greater increase of effective radii upon shock-damping through similar atoms than upon the same through dissimilar atoms. The influence of the damping is revealed by an "optical" shock-time which corresponds to the tinkle-time of the classical oscillator. The half-breadth calculated from the shock-time by Lorentz's methods corresponds to the breadth as calculated by L. Mensing from a commensurability effect. Developments are given and an incidental correction of a datum in a previous paper [see Abstract 1030 (1926)]. **Errata** (*ibid.*, 40. 1–2. p. 166, 1926). A. D.

683. *Periodic Effects of Thin Layers from the Standpoint of the Boundary Problems of the Electromagnetic Theory.* **F. Hlučka.** (Zeits. f. Physik, 38. 8. pp. 589–599, 1926.)—Recently Predwoditelew and Netschajewa [see Abstract 499 (1926)] have investigated the optical and photoelectric phenomena for thin layers of dyestuffs and established a periodic character of the effects observed, *viz.*, of the photoelectric current, transmitted photocurrent and initial velocity of bleaching of the dyestuff. The above authors endeavoured to obtain a theoretical interpretation of these phenomena, and proposed a formula for all three cases giving a connection between the observed extreme values and the concentration of the dyestuff. In the present paper it is shown without the aid of theoretical molecular considerations that periodic phenomena for the optical, photoelectric and photochemical behaviour of very thin absorbing non-metallic layers can be explained solely as a consequence of the fulfilment of the boundary conditions of the electromagnetic theory of light. By the introduction of certain additional assumptions an explanation of the variable amplitudes is also obtained. H. H. Ho.

684. *Stark Effect from the Point of View of Schrödinger's Quantum Theory.* **P. S. Epstein.** (Phys. Rev. 28. pp. 695–710, Oct., 1926. Science, 64. pp. 621–622, Dec. 24, 1926.)—The Schrödinger wave equation for a hydrogen atom in a uniform electric field D parallel to the z axis runs

$$\frac{\partial^2\psi}{\partial x^2}+\frac{\partial^2\psi}{\partial y^2}+\frac{\partial^2\psi}{\partial z^2}+\frac{2\mu}{k^2}\left(E+\frac{Ze^2}{r}-eDz\right)=0.$$

A transformation to parabolical coordinates similar to that of the earlier theory enables solutions for ψ to be obtained in the product form $M(\xi)N(\eta)\,{}^{\cos}_{\sin}\,(s-1)\phi$, where ξ, η and ϕ are the new coordinates. The conditions in a vanishing field are first examined, and then by the method of successive approximations the effect of the field up to the second order is obtained. The positions of the lines are found to be practically the same as in the earlier theory, although certain components now drop out automatically without the special postulate previously necessary. The elements of the Heisenberg matrices are also evaluated by the formula given by Schrödinger and by Eckart. The values so obtained show fair agreement with the experimental results for the intensities of the Stark components for the hydrogen lines. W. S. S.

685. *Electronic States and Band Spectrum Structure in Diatomic Molecules. I. Statements of the Postulates. Interpretation of CuH, CH, and CO Band-Types.* **R. S. Mulliken.** (Phys. Rev. 28. pp. 481–506, Sept., 1926.)—The discussion given in a previous paper [see Abstract 1821 (1926)] is considerably amplified. The author reviews the current theoretical and empirical relations which centre round the Kratzer-Kramers and Pauli formula for the rotational energy contribution to band spectrum terms. It is shown how the structure of bands of CuH, HCl and CN (violet) types, gives information as to the electronic states of the molecules. The assumptions and conclusions arrived at are found to be expressible in three postulates: (1) the electronic states of molecules can be characterised by a term designation analogous to that for atoms, and with which is associated an electronic quantum number j_e whose numerical value is identical with Sommerfeld's atomic inner quantum number j for the given term type; (2) the vector j_e sets itself nearly parallel or nearly perpendicular to the vector m and the rotational energy term is then given substantially by the Kratzer-Kramers and Pauli formula; (3) the molecular j has integral values for odd molecules and half-integral values for even molecules and $\Delta j = 0, \pm 1$. In a final note the modifications introduced by the new quantum mechanics are dealt with. W. S. S.

686. *Deep-Lying Terms in Two- and Three-Valence Electron System Spectra.* **R. A. Sawyer.** (Optical Soc. America, J. and Rev. Sci. Inst. 13. pp. 431–442, Oct., 1926.)—In considering the numerical magnitudes of the frequencies emitted in transitions between the deepest lying terms in atomic spectra, it appears (1) that for elements in the first two horizontal rows of the periodic table (*a*) the lowest PP′ multiplet in three-valence-electron system spectra is near in frequency to the first line in the principal singlet series of the spectrum of the once more ionised atom, (*b*) the lowest PP′ multiplet in two-valence-electron system spectra is near to the first line of the principal series, both of singlets in that system and of doublets in the spectrum of the once more ionised system; (2) that the lowest PP′ multiplet in the arc spectra of calcium, barium and strontium is near to the frequency difference of the lowest S and D terms, both of singlets in the arc spectrum and of doublets in the once ionised spectrum. These relations are analysed from the viewpoint of atomic structure. Essentially they mean that the energy difference between the two lowest states in the above mentioned spectra is little affected by the absence of a second valence electron or by its presence in either the normal or the metastable lowest state. By aid of these relations the following new combinations have been located; In Zn I, $4^3P–4^3P'$ and $4^3P–4^1D''$; in Hg I, $6^3P–6^3P'$; in Mg I, $3^3P–3^1D''$; in Hg II, $6^2P–6^2S$; in Al I, $3^2P–x$.

AUTHOR.

687. *Structure of Rare Gas Spectra.* **W. M. Hicks.** (Ann. de Physique, 6. pp. 294–309, Sept.–Oct., 1926.)—A criticism of certain conclusions arrived at by Block and Déjardin [see Abstract 853 (1925)] in regard to regularities found by Hicks in the spectra of argon, krypton, and xenon. The author here gives a *résumé* of his theory of spectral regularities; and then shows how his earlier statements are reasonable in the light of his theory. As the electrical excitation becomes more violent the arc spectrum first produced passes over into the spark spectrum and then into higher spark spectra. But at the same time, according to the author, terms properly belonging to the arc spectrum become split into more complex terms, just as in doublets a simple p term is resolved into p_1 and p_2. Thus "collaterals" arise at the expense of the original line; the displacements of these collaterals are subject to well-defined laws. In high excitation a line may be replaced altogether by collaterals, and can be inferred from them. Thus lines appearing together with true spark lines may really belong to the arc spectrum. Linked lines also occur in high stages of excitation connected with other lines by calculable "links." Summation-lines of the form $1p + m\text{S}$, *e.g.*, are found. Triplets were found in the spectra of all the rare gases, argon to niton, as well as triplets in the far *u–v* not yet measured, but inferred by "sounding" with "links." These triplets are in good agreement with the requirements of Hick's theory. The ionisation potentials calculated from the terms found are in agreement with observed values if allowance is made for what is called the "work of preparation." The objections of B and D are then reviewed in detail, and examples given of the use of the "oun" in connection with displacements. A. C. M.

688. *Continuous Spectrum of Hydrogen.* **I. M. Freeman.** (Astrophys. J. 64. pp. 122–127, Sept., 1926.)—A number of workers have observed a continuous spectrum due to hydrogen which commences in the visible region and extends far into the ultra-violet. It is excited by slow electrons at rather high pressures, and is distinct from the Bohr spectrum encountered at the series limit. A special form of tube with hot, coated kathode is described which shows this type of spectrum. Intensity measurements with a Brace-Lemon spectrophotometer show a maximum of spectral energy between 4800 Å. and 5100 Å. F. S.

689. *Large Displacements of Spectral Lines of Chlorine.* **K. Asagoe.** (Kyoto Coll. Sci., Mem. 10. pp. 15–23, Sept., 1926. In English.)—Two spectrographs were used—a five-prism glass spectrograph for the region λ4585–λ3833, and a concave grating of 3-metre focus from λ5457–λ4585 and from λ3833 to the ultra-violet. Tables of wave-lengths and displacements due to variations of excitation are given for both arc and spark lines. The lines are classified into three types, some of those belonging to one class suffering a shift of about 2 Å. towards the red. F. S.

690. *Note on the Interpretation of Wood's Iodine Resonance Spectrum.* **E. C. Kemble** and **E. E. Witmer.** (Phys. Rev. 28. pp. 633–641, Oct., 1926.)—The paper gives a re-analysis of the resonance series described by Mecke [see Abstract 2420 (1923)], using the formula developed by Kratzer and Sudholte [see Abstract 2291 (1925)]. The series are correlated with the absorption bands near the exciting mercury line. The recomputed values of the moment of inertia for the normal state ($n = 0$) and for the excited electronic level ($n = 26$ to 29) are $8 \cdot 1 \times 10^{-38}$ gm. cm.^{2} and $12 \cdot 5 \times 10^{-38}$ gm. cm.^{2} respectively. The origin of these bands is very close to the head, the value of m'' for the head being $1 \cdot 81$. AUTHORS.

691. *Intensities in the Iron Spectrum. Part II.* **J. B. van Milaan.** (Zeits. f. Physik, 38. 6–7. pp. 427–436, 1926.)—A continuation of an earlier paper [see Abstract 739 (1926)], in which the author describes the result of intensity measurements for the lines of certain iron multiplets. In this second part, the multiplets $f' - d^2$, $\bar{d} - d$, $p^1 - d^2$, $f' - \overline{f^2}$, and $d' - f'$ are measured. The first and third of these multiplets have line intensities in good agreement with the sum-rule. The multiplets $\bar{d} - d$ and $\overline{f'} - f$ are in poor agreement; for this slight self-reversal is blamed, and it is shown that the trend of the intensities is in such a direction that a much weaker current would probably give rise to intensities in agreement with the rule. A. C. M.

692. *Multiplets in the Spark Spectrum of Iron.* **H. N. Russell.** (Mount Wilson Observat. Contrib. No. 318. Astrophys. J. 64. pp. 194–203, Oct., 1926.)—All the lines of astrophysical importance have been classified with the aid of material prepared by Merrill, Anderson and Babcock. Multiplets belonging to sextet and quartet systems have been found. So far 214 lines have been grouped into 35 multiplets, involving combinations between 16 terms. The state of lowest energy in the ionised atom corresponds to a ^{6}D-term, the next to a ^{4}F′-term. The observed terms are in excellent agreement with the predictions of Hund's theory, and are from the electronic configurations s^2d^5, sd^6, d^7, and d^6p. Only the lowest terms of the quartet system out of a large number predicted have yet been found, and an intricate system of doublets should exist. This agrees with the fact that many lines are still unclassified. Work on this spectrum will be continued. AUTHOR.

693. *Fine Structure of Bismuth Lines.* **H. Nagaoka** and **T. Mishima.** (Imp. Acad. Tôkyô, Proc. 2. pp. 249–251, July, 1926. In English.)—Using the method of crossed Lummer-Gehrcke plates the difference of wave-length between the satellites of bismuth lines in the ultra-violet was determined. A table is given showing these differences, and also the relative intensities of the satellites. The structure of certain lines showed differences depending on which of the two methods of excitation was used. W. S. S.

694. *Instantaneous Photographs of Electrically Exploded Wires.* **H. Nagaoka** and **T. Futagami.** (Imp. Acad. Tôkyô, Proc. 2. pp. 387–389, Oct., 1926. In English.)—The general features of the explosion of wires have previously been described [see Abstract 438 (1927)]. The present paper gives several photographs obtained by focussing the image of the wire on a rapidly revolving disc to which was attached the photographic film, the light passing through a slit in front of the disc. Photographs are reproduced for wires of copper, manganin and iron, also for magnesium ribbon. The results confirm previous observation by the eye. A. W.

695. *Explosion Spectra of Mercury.* **H. Nagaoka** and **T. Futagami.** (Imp. Acad. Tôkyô, Proc. 2. pp. 254–257, July, 1926.)—The methods used for obtaining the explosion spectra are (1) vaporisation of mercury oxide between carbon electrodes by the passage of a heavy discharge current, and (2) explosion of a fine jet of mercury carrying a current of over 1000 amps. (estimated temperature greater than 10,000° C.). The lines obtained are tabulated and compared with those given by mercury vapour in a quartz lamp. In the explosion spectra most of the series lines, except the principal, become faint and nebulous, whilst lines due to ionised mercury are nearly all strengthened. In addition to the mercury lines, lines of gold and thallium were observed in the explosion spectra. W. S. S.

696. *Absorption Spectra of the Palladium and Platinum Triads.* **W. F. Meggers** and **O. Laporte.** (Phys. Rev. 28. pp. 642–664, Oct., 1926.)—Under certain conditions the continuous spectrum from high potential sparks between metal electrodes immersed in a liquid is interrupted by absorption lines which are identifiable with lines in the arc emission spectrum of the metal. The importance of these lines lies in the fact that in numerous cases where the spectral structures are known, they have been shown to involve the normal state and sometimes low metastable states of the atoms. By extending these observations to unclassified spectra, this method thus permits the identification of the low levels in the spectral structures. Using electrodes of Ru, Rh, Pd, Os, Ir and Pt, in the under-water spark, the absorption spectra of these metals were determined down to wave-lengths near 2000 Å. Analyses of these data reveal the low levels in the arc spectra of the Pd and Pt triads as follows: the lowest energy is represented by a quintet-F term for Ru, by a quartet-F for Rh and by a singlet-S for Pd. A considerable number of the absorption lines for Os, Ir and Pt have been classified with levels, but it is impossible at the present time to recognise their spectral types, except that for Ir the lowest level is probably a doublet-D term and for Pt it is probably a triplet-D. The quantum-theoretical arrangement of low levels as derived from the electron configurations in these atoms is summarised. AUTHORS.

697. *New Terms in the Spectrum of Calcium.* **R. J. Lang.** (Astrophys. J. 64. pp. 167–171, Oct., 1926.)—The vacuum-spark spectrum of Ca shorter than 2000 Å. has been photographed with a 6-ft. grating *in vacuo* having 30,000 lines per in. and giving an average dispersion of 4·5 Å. per mm. Some of the known lines of Ca + have been remeasured, especially those of the first fundamental series, and compared with the values published by Saunders and Russell [see Abstract 2510 (1925)]. Two new terms are given which combine with many of the known terms, especially with the dashed terms. AUTHOR.

698. *Absorption Spectra of Pyrone Derivatives in the Near Infra-Red.* **A. Ross.** (Roy. Soc., Proc. 113. pp. 208–220, Nov. 1, 1926.)—Many chemical and physical properties of pyrone compounds are at variance with the molecular structures assigned. The absorption spectra of some derivatives have therefore been investigated to see whether the structure can be confirmed, and also to test the utility of the method for routine organic analysis. The evidence is in favour of a benzene nucleus and an hydroxyl group in the pyrone molecule. As a routine method in organic chemistry, it is decided that while only qualitative results are required, the method is fruitful. A. C. M.

699. *Stripped Yttrium* (Y_{III}) *and Zirconium* (Zr_{IV}). **I. S. Bowen** and **R. A. Millikan.** (Phys. Rev. 28. pp. 923–926, Nov., 1926.)—Using aluminium electrodes, first with yttrium oxalate and borax fused into their cores, and second with zirconium hydroxide replacing the yttrium oxalate, the hot spark spectra of Y_{III} and Zr_{IV} have been identified and the series relationships and term values analysed. The results are tabulated. In these stripped atoms the normal position of the electron is in a 4*d* orbit rather than in a 5*s*. AUTHORS.

700. *Precision Measurements in the L Series of the Elements Tungsten to Uranium.* **E. Friman.** (Zeits. f. Physik, 39. 10–11. pp. 813–827, 1926.)—This paper describes measurements with experimental details of the strongest L-lines (α_1, β_1, β_2, γ_1) of the elements tungsten, iridium, platinum, gold, mercury, thallium, lead, bismuth, thorium and uranium, and also of the majority of the weak lines. These were made with the new precision tube spectrometer of Siegbahn and Larsson. Crofutt's paper should be consulted [see Abstract 2279 (1924)]. H. H. Ho.

701. *Theory of Absorption of X-Rays.* **R. A. Houstoun.** (Phil. Mag. 2. pp. 512–520, Sept., 1926.)—In considering the absorption of X-rays by matter, the author assumes a system of slightly damped electronic oscillators of natural frequencies distributed between the critical absorption frequency and infinity, these oscillators absorbing energy all the time. The views set forth in the paper lead to a result similar to that in the "escapement theory" of Larmor [see Abstract 259 (1922)], in which the electronic radiator is regarded as analogous to the pendulum of a clock driven by the energy of a coiled spring which is fed into the motion by an escapement; the model being regarded as reversible, the pendulum may feed its energy back through the escapement into the spring. As an example illustrating the theory the author takes the case of Fe within the region of the K absorption, 25 of its 26 electrons are taking energy from the incident rays and scattering it, losing it by resonance radiation. The remaining electron absorbs energy from a narrow region somewhere between the head of the band and infinite frequency; it scatters a small proportion of this energy but transmits most to another system of which nothing is known. Its own energy never becomes more than an insignificant fraction of the appropriate quantum. Outside this limited region the remaining electron scatters as well as the others. A. B. W.

702. *The Compton Effect and the Reflection of X-Rays by Crystals.* **E. J. Williams.** (Phil. Mag. 2. pp. 657–672, Sept., 1926.)—The laws which would apply to the reflection by a crystal of modified radiation scattered by its own electrons are derived by considering an electron lattice moving with a velocity that would give as a Doppler effect the change in wave-length demanded by the quantum theory of scattering. The difference between these and the ordinary Bragg laws of scattering is appreciable, and as all the radiation actually reflected obeys Bragg's law, it is concluded that (*a*) no modified radiation is scattered by the electrons in the directions concerned, or (*b*) modified radiation is scattered, but is not regularly reflected. The bearing of the Compton effect on the theory of the intensity of reflection by crystals is considered on the basis of the second alternative; and an outline of the way in which the revised F-curves have been calculated is given. The "classical" F-curves, the revised curves and the "observed" curves are compared. The revised F-curves are little influenced by the contribution from the outer electrons because these electrons scatter very little modified radiation, and as a result they agree much better than the classical curves with the curves actually observed. The correction for the Compton effect is a function of sin β/λ, and in this respect resembles other factors entering into the theory of the intensity of reflection. The capacity of a crystal to reflect modified and unmodified radiation is discussed. A. B. W.

703. *Soft X-Rays: Improvements in Technique and New Results for C, Cu, and W.* **K. T. Compton** and **C. H. Thomas.** (Phys. Rev. 28. pp. 601–612, Oct., 1926.)—A new tube designed for high sensitivity in detecting soft X-rays by their photoelectric action and using a system of gauzes to exclude ions from the detecting plate was found to give results identical with the previous tube in which a vane system was employed. In either type of tube the range of voltage applied to exclude ions from the detecting plate must be determined. Failure to observe this seems to account for some results which have appeared in the literature of this subject. Greatly increased precision was secured by measuring both the thermionic and the photoelectric currents, I and E, by balanced methods in which the full scale of the instruments was used to measure current increments, instead of total currents, as the voltage was increased in small steps. The applied voltage V was measured by a similar balanced method in which residuals only were read on the voltmeter. By these devices the observations were so precise that critical potentials could be determined from curves in which were plotted the second differences of the ratio E/I against V, which rendered discontinuities much more marked than in previous methods. The method is illustrated by application to tungsten in a small voltage range. Sixty-two critical potentials were found for carbon in the range 0–160 volts. Thirty-one new critical potentials of copper were found in the range 65–280 volts, which had not previously been investigated for fine structure. These critical potentials are given in tables. AUTHORS.

704. *The K X-Ray Absorption of Calcium in Calcite, Gypsum and Fluorite.* **G. A. Lindsay** and **G. D. van Dyke.** (Phys. Rev. 28. pp. 613–619, Oct., 1926.)—The K X-ray absorption edge of calcium has been photographed with the object of studying the fine structure of the edge. The absorption occurred in the reflecting crystal itself, thus rendering unnecessary any absorbing material other than the crystal. Three crystals were used—calcite, gypsum and fluorite. The fine structure of the edge shows as many as four subdivisions. The explanation is probably, as suggested by Kossel, that the electron ejected from the K orbit by the absorption stops in some of the unoccupied orbits, and in case of a calcium ion which we undoubtedly have in these crystals, the energy difference of these different virtual orbits is sufficient to show as a fine structure of the edge. AUTHORS.

705. *Disappearance of the Unmodified Line in the Compton Effect.* **G. E. M. Jauncey** and **R. A. Boyd.** (Phys. Rev. 28. pp. 620–624, Oct. 1926.)—Measurements on the scattering by carbon of X-rays of wavelengths 0·41 and 0·47 Å. are presented in the form of curves showing the variation of the ratio of the modified to the total scattering as a function of the angle of scattering. Although the curves show that the unmodified scattering does not disappear at any angle up to 120°, there are distinct decreases in slope at the angles at which Jauncey's theory of scattering by K electrons requires the disappearance of the unmodified ray. This is regarded as demonstrating the applicability of the theory to scattering by K electrons. On the other hand an extension of the theory to scattering by L_1 electrons leads to results not in accord with experimental facts. AUTHORS.

706. *Polarisation of Characteristic X-Rays.* **J. B. Bishop.** (Phys. Rev. 28. pp. 625–632, Oct., 1926.)—Primary X-rays from a molybdenum target Coolidge tube were allowed to impinge upon a carbon block, and the intensity of the scattered radiation proceeding from this secondary source was compared in two directions mutually perpendicular to the primary rays and parallel to and perpendicular to the kathode stream respectively as the tube was rotated. When the tube was operated at 29 kV peak and the primary radiation made to pass through a suitable filter of zirconium, the radiation was rendered practically monochromatic and was composed mainly of the K-alpha lines. The ratio of the intensity of the secondary beam proceeding in a direction parallel to the kathode stream to that proceeding in a direction perpendicular thereto was then taken as a measure of the polarisation of the alpha lines. This ratio was found to be about 0·74. Operating the tube under the same conditions as stated above but using a filter of strontium, which served to cut out the alpha lines, the corresponding ratio was 0·84. These results indicate that the α-lines of molybdenum are partially polarised. AUTHOR.

707. *Direct Measurement of X-Ray Mass Scattering Coefficient.* **P. Mertz.** (Phys. Rev. 28. pp. 891–897, Nov., 1926.)—The mass scattering coefficients for Li, B, C, H_2O and Na at wave-lengths λ0·32, 0·43, 0·54, 0·66, 0·79 Å. were measured directly by collecting the scattered radiation in an ionisation chamber surrounding the scatterer, and comparing its intensity with that of a portion of the primary beam going through an auxiliary ionisation chamber of equal length along the ray path. The primary beam consisted of the continuous radiation from a Coolidge tungsten tube, filtered through Al and Cu until the spectral width between the half-maximum intensity points was about 25 % of the mean wave-length. Corrections were made for internal absorption in the scatterer and for the increased absorption of the scattered beam in the ionisation chamber due to the Compton effect. The uncertainty in these corrections forms the chief limitation on the accuracy of the measurement. The values of mass scattering coefficient determined are tabulated. The scattering coefficient in all cases starts, for short wave-lengths, below the value computed from Thomson's formula, and slowly increases for longer wave-lengths. For all substances but boron it finally crosses the Thomson value because of gradual entering in of excess scattering.

AUTHOR.

708. *Some Effects of Temperature on X-Ray Absorption.* **H. S. Read.** (Phys. Rev. 28. pp. 898–906, Nov., 1926.)—The previous results of the author [see Abstract 1840 (1926)] showing a change with temperature of the average atomic absorption coefficients of various metals for X-rays have been confirmed in the case of Ag and Ni. The complete radiation from an X-ray tube operated at 50,000 volts was used. Heating silver to 830° C. decreased its transmission about 1·3 %. Heating Ni to from 700° to 1000° C. decreased its transmission about 1·7 %. Spectroscopic resolution of the X-rays passed by a silver absorber alternately heated to 830° C. and cooled to room-temperature demonstrated a marked variation with wave-length of the effect of temperature on the atomic absorption coefficient. The variation was most marked near the K absorption limit of Ag. On the short wave-length side heating the silver to 830° C. increased the atomic transmission about 1 %, whereas on the long wave-length side it was decreased about 1·5 %. If this change be interpreted as due to an increase in the wave-length of the K-limit, calculation shows the increase to be about 0·21 X.U. AUTHOR.

709. *X-Ray Investigation of the Normal Saturated Dicarboxylic Acids and their Ethyl Esters.* **A. R. Normand, J. D. M. Ross** and **E. Henderson.** (Chem. Soc., J. pp. 2632–2637, Oct., 1926.)—The investigation shows that the even and the odd members of the dicarboxylic acids belong to two distinct series. So far as the results go, the odd and the even members of the diethyl esters of these acids form one series. From the spacings observed, it is concluded that the monoethyl esters contain two molecules, whilst the other substances examined contain only one molecule between successive reflecting planes. A. B. W.

RADIOACTIVITY.

710. *Spontaneous "Radiationless" Quantum Phenomena.* **A. Smekal.** (Ann. d. Physik, 81. 4. pp. 391–406, Oct. 8, 1926. Phys. Zeits. 27. pp. 831–835, Dec. 15, 1926. Paper read before the Deut. Naturforscher u. Ärzte, Düsseldorf, 1926.)—It is shown that the principal radiationless corpuscular emission processes, considered in the usual sense, can have no finite probability. The only satisfactory hypothesis to fit the facts involves the assumption of an "internal" absorption of radiation. The author considers the theoretical effects of this hypothesis in relation to observation. A. B. W.

711. *Anomalous Scattering of α-Rays.* **W. Hardmeier.** (Phys. Zeits. 27. pp. 574–576, Sept. 1, 1926.)—Refers to a previous paper [see Abstract 1842 (1926)] giving results of a preliminary calculation of the scattering of α-rays in passing through thin foils of light elements; the present paper, using the same assumptions as to the polarisability α of the atomic nuclei, derives an accurate formula for the scattering, obtaining an elliptic integral by means of which the forms of the paths of the α-particles and the angles between their final and original directions can be calculated for different initial conditions. It appears that the former approximate calculation gives the characteristic behaviour of the α-particles as long as the angle is not much larger than 90° and the velocity of the α-particle is not too great. The new theory explains the deviations from the normal scattering for high velocities or deviation, and the results of the calculations for $\phi = 135°$ agree quite well with the measurements of Rutherford and Chadwick for aluminium, when α is taken as $0{\cdot}5 \times 10^{-36}$ cm.^{3}; this agrees with the theory according to which α should be of the same order as the volume of the nucleus. The paper gives interesting details as to the nature of the paths of the α-particle round the nucleus under different conditions, and explains how the α-particle may be imprisoned by the nucleus. Smekal has recently brought forward a number of factors which must complicate the simple assumption employed, but while the author does not dispute the existence of these factors, he considers that as a first approximation the theory he has evolved gives a very good explanation of the facts. H. N. A.

712. *Effect of α-Rays on Supersaturated Solutions.* **W. J. Richards.** (Comptes Rendus, 183. pp. 598–600, Oct. 11, 1926.)—The utility of the Wilson expansion apparatus is well known—making use of air saturated with water vapour to make visible tracks of ionising particles. The author now considers the analogous problem of the production of visible tracks by the projection of α-particles in supersaturated solutions of crystalline salts. An α-particle produces locally three intense effects: ionisation, heat and mechanical shock. It seems reasonable to suppose, therefore, that an α-particle might, by reason of one of these effects, cause "cessation of supersaturation" (*i.e.*, crystallisation) in a liquid. Similarly chemical precipitation might be accelerated by α-rays. The author examines a large number of cases of supersaturated solutions (of solids, liquids and gases, in liquid solution) and of chemical precipitations, with varying degrees of success. A. B. W.

HEAT.

713. *Method of Measuring the Heat Conductivity of Solids in the Form of Plates.* **M. Jakob.** (Zeits. techn. Physik, 7. 10. pp. 475–481, 1926.)—A detailed description of an improved form of apparatus developed by the author for the measurement of the conductivity of badly conducting substances. In the author's earlier apparatus a vacuum jacket was used to diminish radiation losses [see Abstract 477 (1921)]. This has been replaced by electrical heaters, which have proved very efficient. The method used is that of stationary heat flow, the temperatures in all cases being measured with thermojunctions. The most important detail in connection with the measurements is the extreme care with which the plate to be tested has to be cemented between the heater and the receiver cooled by running water. Paraffin wax or bitumen is used for the cement, and careful measurements are made in separate experiments of the value of their conductivity. The most important correction is the temperature drop in the cement layer, which amounts to 8 % of the total drop. Heat losses are practically annulled by the electrical heaters. The accuracy attained is estimated to be 1 %. T. B.

714. *An Apparatus for the Measurement of the Thermal Expansion of Solids.* **E. Braun.** (Zeits. techn. Physik, 7. 10. pp. 505–508, 1926.)—The apparatus is suitable for the measurement of the expansion of rods between 5 and 10 cm. in length and gives an accuracy of about 0·5 %. It consists of an outer envelope of quartz closed at its lower end into which is sealed a pointed end-piece. On this end-piece rests the rod under examination, the other end of which is in connection with one of the prisms of a double prism system. This double prism system constitutes in effect a type of optical lever. Heating is carried out by immersing the quartz envelope in an oil bath or electric furnace. A. A. D.

715. *Expansion Coefficient and Free Space in Liquids.* **W. Herz.** (Zeits. Elektrochem. 32. pp. 460–462, Sept., 1926.)—The tables of the author show that there is, for most liquids, a fairly constant relation between the free space [see Abstract 1605 (1926)] and the expansion coefficient (deduced from the density). The tables concern heptane (typical organic compound), tin tetrachloride (inorganic compound), acetic acid (associated liquid) and chlorine (liquefied gas). Both the free space and the expansion coefficient increase with rising temperature in such a way that the quotient of the two values is fairly constant; near the critical temperature the expansion coefficients increase relatively more rapidly so that the quotients decrease. In the case of water (a table for which is not given) the expansion is always relatively large and the relations become more constant only above 400° K. H. B.

716. *Coefficients of Expansion at Low Temperatures and Thermodynamic Applications of Expansion Data.* **R. M. Buffington** and **W. M. Latimer.** (Am. Chem. Soc., J. 48. pp. 2305–2319, Sept., 1926.)—This paper records data on coefficients of thermal expansion of solids at low temperatures obtained for the purpose of testing theories of the solid state. The mathematical development of such theories involves certain differential coefficients, *e.g.*, the various elastic moduli, the specific heat, and the coefficient of expansion, and the functional relations of these quantities in consequence require experimental investigation. The approximate validity of the Grüneisen relation and the known behaviour of specific heats satisfactorily confirm the third law of thermodynamics, but the data now obtained show that expansion measurements at still lower temperatures are required for adequate tests of the theories of lattice mechanics such as those of Grüneisen and Born. The expansion measurements now recorded were made by a modified Fizeau method in which the displacement of a system of interference bands gives length changes in terms of the half wave-length of the light used. Full experimental details are included, and tables of results are given for aluminium, copper, silver, rock-salt, pyrex glass and quartz. Errors are adequately discussed, previous work described, and applications considered. A final section is devoted to interatomic constraints and entropy. H. H. Ho.

717. *Specific Heat of Carbon Steels.* **S. Umino.** (Tôhoku Univ. Sci. Reports, 15. pp. 331–369, July, 1926. In English.)—The specific heats of twelve kinds of steels of carbon content 0·09 % to 2·84 % have been determined at temperatures 23° to 1250° C. by the method of mixtures. To prevent oxidation, hydrogen was passed continuously through the furnace. It is found that above the temperature of the "A_3 point," where the structure is entirely austenetic, the specific heat is approximately constant. Below this point it increases with rise of temperature. It is shown that the "A_1 transformation"—the dissolution or precipitation of cementite in iron—is a function of temperature and time, but the "A_2 transformation"—which, according to K. Honda, is a gradual change of energy in the iron atoms themselves—is a function of temperature only. The heat of transformation from martensite to pearlite is proportional to the C content of the steel. For the dissolution of 1 gramme of C in iron 1760 calories are required, while for 1 gramme of pearlite only 16·1 calories are necessary. Tables and graphs are given, and the latter indicate a discontinuity in the specific heat which occurs at the A_3 transformation point in steels containing 0·00 to 0·795 % of carbon. T. B.

718. *Investigations in the Critical Region. Part I. Specific Heat of Carbon Dioxide at the Critical Point.* **K. Bennewitz** and **E. Splittgerber.** (Zeits. phys. Chem. 124. pp. 49–65, Oct. 28, 1926.)—Measurements of the specific heat at constant volume of carbon dioxide in the region of the critical points are made by placing a steel vessel containing a definite amount of the compressed compound in a calorimeter at temperatures varying in stages from 0° to 44° C., and measuring with a platinum resistance thermometer the rise of temperature produced by applying a known amount of heat by means of a current passed through a resistance coil. The relative masses of liquid and gas phase when in equilibrium at different temperatures are calculated from density data. Below the critical temperature the observed heat capacity is the sum of the specific heats and the latent heat of vaporisation which is calculated from the Clausius-Clapeyron equation $r = \mathrm{T}dp/d\mathrm{T}(v_1-v_2)$ by means of data by Amagat. A curve is plotted giving the variation with temperature of the specific heat values of the gas. In the neighbourhood of the critical point, 31·3° C., an oscillation in the curve is given and negative values of the specific heat are obtained which may be attributed to superheating effects. As an alternative explanation a view of Nernst is referred to in which the system at the critical point consists of two phases of which each one represents a solution in the other with the property that the solute and solvent may interchange and give a negative heat of reaction. In the heterogeneous region the specific heat values measured are in close agreement with those calculated thermodynamically from known data.

J. N. P.

719. *Quantum Theory of the Specific Heat of Hydrogen. Part I. Relation to the New Mechanics, Band Spectra and Chemical Constants.* **J. H. van Vleck.** (Phys. Rev. 28. pp. 980–1021, Nov., 1926.)—The failure of the simple theory is held to be due to the non-polar character of the hydrogen molecule, and is probably intimately connected with the alternating intensities found in the band spectra of certain non-polar molecules. Various ways of removing the specific heat dilemma are considered at length. Croze and Dufour's peculiar Zeeman doublets, whose polarisation is sometimes anomalous, are shown to be due to loose coupling of the spin axis of the valence electron in either the initial or final state, but not in both. The Stern-Tetrode formula for chemical constants has been modified by including terms involving the *à priori* probability of the lowest state and the symmetry number. The moment of inertia 10^{-41} gm. cm.^{2} often deduced for the hydrogen molecule from chemical constants is shown to be erroneous.

H. H. Ho.

720. *Quantum Theory of the Specific Heat of Hydrogen. Part II. Comparison of Various Theories with Experiment.* **E. Hutchisson.** (Phys. Rev. 28. pp. 1022–1029, Nov., 1926.)—Gives a comparison of the various theories with the available experimental data. Average values are compiled for the specific heat of hydrogen at various temperatures up to 1000° K. [see Abstract 960 (1918)], but these are not in agreement among themselves, and at high temperatures uncertainty exists. Computations have therefore been made based mostly upon van Vleck's theory [see preceding Abstract], but using different minimum values of the rotational quantum numbers and different *à priori* probabilities for both rigid and elastic models. It is shown that half integral vibrational quantum numbers do not appreciably affect the specific heat except to change an arbitrary constant. Witmer's spectroscopic values for the normal vibration frequencies have been confirmed theoretically.

H. H. Ho.

721. *Distribution of Thermal Energy in Organic Molecules.* **D. H. Andrews.** (K. Akad. Amsterdam, Proc. 29. 5. pp. 744–753, 1926.)

722. *Heat Capacities and Heat of Crystallisation of Some Isomeric Aromatic Compounds.* **D. H. Andrews, G. Lynn** and **J. Johnston.** (Am. Chem. Soc., J. 48. pp. 1274–1287, May, 1926.)—From the experimental results given the heat of melting and the specific heat prove to be greater for the para than the corresponding ortho isomer; the values for the meta isomer show no apparent regularity. The molal heat capacities of the several substances as solids at 25° lie within a narrow range of values; this is particularly true for the fluids of ortho, meta and para isomers.

723. *The Specific Heats of Some Isomers of the Type Ortho, Meta and Para C_6H_4XY from 110° to 340° K.* **D. H. Andrews.** (Am. Chem. Soc., J. 48. pp. 1287–1298, May, 1926.)—The measurements of the specific heats of eleven isomers of the type ortho, meta and para C_6H_4XY, carried out in a new type of calorimeter explained in the paper, show that the specific heat is a function of the temperature from 110° to about 320° K., and is but slightly changed by the difference in structure between the isomer types.

724. *Latent Heats of Vaporisation of Ethyl and Methyl Chlorides.* **G. W. C. Yates.** (Phil. Mag. 2. pp. 817–826, Oct., 1926.)—The latent heat of vaporisation of ethyl and methyl chlorides is determined by equating the amount of heat communicated to the calorimeter containing the liquid under investigation to the heat lost by the evaporation of a known weight of the liquid + the heat lost by emission + the heat used in raising the temperature of the calorimeter. The values obtained were: Ethyl chloride, 92·0 cals. per gm. at 21° C.; ethyl chloride, 95·2 cals. per gm. at 20° C. These results are compared with those of Regnault [Ann. Chim. Phys. (4), 2–4. pp. 423 and 438 (1871)], Chappuis [Ann. Chim. Phys. 15. pp. 498–517 (1888)], and of the Special Report No. 19, 1923, of the Food Investigation Board. B. W. C.

725. *Determination of High Temperature by the Effusion and the Transpiration of Gas.* **Y. Yamaguchi.** (Chem. Soc. Japan, Bull. 1. pp. 209–215, Oct., 1926. In English.)—Three methods are studied for the determination of high temperature by the observation of the rate of flow of gas. The methods depend on three relationships: (1) The relation between the temperature and the rate of effusion. The results show that the expression $t = a + b\sqrt{T}$ is valid up to about 1000° C. from ordinary temperatures, t being the time of efflux of air through a quartz opening, a and b constants, and T the absolute temperature. (2) The relation between the temperature and the rate of transpiration: The method adopted is the transpiration through a quartz capillary. From the ordinary temperature to 1000° C. the relation is given by the expression $\log T = a + b \log t + c(\log t)^2$. (3) The relation between the temperature and the pressure of gas transposing at a definite rate: In the range from ordinary temperature to 1200° C. a linear law is followed given by the equation $\log p = a \log T + b$.

The paper is complete with tables for the determination of the constants. S. G. B.

726. *The Ideal Expansion Curve.* **L. Schames.** (Phys. Zeits. 27. pp. 630–631, Oct. 15, 1926.)—A discussion on the character and form of the ideal expansion curve. The results are illustrated in tables and curves, and the agreement with the results of Bridgeman, Mack, Ramsay and Young for ether and Amagat for CO_2 are pointed out. The hyperbolic character of the curve is discussed and elucidated. S. G. B.

727. *The Calibration of Resistance Thermometers at the Oxygen Boiling Point and the Carbon Dioxide Sublimation Point.* **A. G. Loomis** and **J. E. Walters.** (Am. Chem. Soc., J. 48. pp. 3101–3107, Dec., 1926.)—The need for the accurate calibration of resistance thermometers at the normal boiling point of oxygen and the normal sublimation point of carbon dioxide is discussed. It is concluded that the most probable value of the oxygen point is − 183·00 ± 0·02°, and of the carbon dioxide point − 78·51 ± 0·01°, both on the thermodynamic scale. Various precautions for the accurate determination of these points are described, including the preparation of pure oxygen and carbon dioxide, the use of suitable cryostats, and means of avoiding lag in the vaporising substance. The magnitude of probable errors is discussed. [See also Abstract 1429 (1925).] J. N. P.

728. *The Gas Theory Basis of the Stokes-Cunningham Formula.* **T. Sexl.** (Ann. d. Physik, 81. 8. pp. 855–865, Nov. 27, 1926.)—Weyssenhoff [see Abstract 1235 (1920)] has already commented on the extremely feeble theoretical basis of the Stokes-Cunningham formula without proving that it is so. In the first part of the present paper it is shown that the formula is untenable. In the second part positive observations are given which, on a strong gas theory basis, leads to a formula identical with that of Stokes-Cunningham, but of which the constant has an entirely different physical basis. A. E. G.

729. *Diverse Applications of the Equation of Transfer of the Kinetic Theory of Gases.* **J. Haag.** (Ann. de Physique, 6. pp. 254–293, Sept.–Oct., 1926.)—In the first part of this mathematical paper Boltzmann's equation of transfer is introduced and a method for the calculation of the molecular velocity after collision submitted, which appears more convenient than that usually adopted. In the second part a treatment is given of the problem of diffusion in a mixture of gases for each component of which the Maxwellian law of distribution of molecular velocities holds good, although the macroscopic velocity, temperature and density of each component are assigned arbitrary values. A study of the viscosity and thermal conductivity of a simple gas in a state for which Maxwell's law holds only approximately, occupies the third section of the paper. Making certain simplifying assumptions the coefficient of viscosity and the thermal conductivity are found to be given by the formulæ $\eta = \frac{2}{3} \cdot \frac{RT}{\pi k}$, and $\Gamma = \frac{5}{2}\eta C_v$, where k is a function of the absolute temperature T depending on the intermolecular law of force, and C_v is the specific heat at constant volume. W. S. S.

730. *Relative Ignition Temperatures of Solid Fuels.* **K. Nakamura** and **A. Shimomura.** (Kyoto Coll. Sci., Mem. 10. pp. 89–94, Nov., 1926. In English.)—Twenty-two kinds of solid fuels, including lignites, bituminous as well as anthracitic coals of oriental origin, semi-coke, metallurgical coke and wood-charcoal were tested for their relative ignition temperatures in the sense of Wheeler's definition. A special form of heating tube with a paraffin-bath fused in was used, and was found to give more uniform heating than the ordinary tube such as Wheeler used. Wheeler's general conclusion that the higher the oxygen content of the coals the lower the relative ignition temperature has been confirmed with most of the coals examined. It was found, moreover, that the volatile matter and the ash-contents of the fuel have a decided influence on their relative ignition temperatures, a high volatile or a low ash-content giving in general a low ignition temperature, provided the other conditions remain equal. AUTHORS.

731. *The Pressure Wave Caused by an Explosion.* **W. Payman, H. Robinson** and **W. C. F. Shepherd.** (Safety in Mines Research Board, Papers Nos. 18. and 29. Engineering, 123. pp. 58–60, Jan. 14, 1927.)—In an explosion, where gases are liberated and expanded, two main waves may be distinguished, the shock wave, and behind it the pressure wave. The experiments confirm the assumption that ignition of fire-damp and of coal dust may be produced by the flame of the explosion, by the shock wave and by the pressure wave, or by combinations of the three, whilst the shock wave may even counteract the effect of the flame. The apparatus employed consists of a wave camera, which records the speed of the main wave and the movements of the flame and of the gaseous detonation products on the same film. It is demonstrated that the flame soon dies out, but remains always behind the shock wave and within a blanket of incombustible gas, never coming in direct contact with the external air. This explains why detonator flames do not ignite fire-damp and coal-dust air mixtures. T. B.

732. *Heats of Evaporation of Some Condensed Gases at Low Pressures.* **A. Eucken** and **E. Donath.** (Zeits. phys. Chem. 124. pp. 181–203, Nov. 28, 1926.)—In this paper a method is described for measuring the heat of evaporation (or sublimation) which is available down to vapour pressures of about 1 mm., and which renders accurate results in normal cases to about 1 %. Measurements have been carried out with solid and liquid ammonia, solid carbon dioxide, nitrous oxide and hydrogen chloride, tables of results being included. From the temperature coefficients of the heats of evaporation and the known molecular heats of the condensed gases the molecular heats of the vapours are calculated to an accuracy of a few per cent., and the valves obtained for carbon dioxide and nitrous oxide favour the assumption of a completely extended molecular structure. The data found for the heats of evaporation of ammonia and carbon dioxide enable a recalculation of the integration constants j_p which have hitherto been evaluated from the course of the vapour pressure curve; for ammonia the new value is less by about 0·035, but for carbon the earlier result is completely confirmed. H. H. Ho.

733. *Equation of Vapour Pressure at Low Temperatures.* **V. Fischer.** (Zeits. f. Physik, 39. 10–11. pp. 879–882, 1926.)—In a previous paper [Abstract 2297 (1924)] the author deduced the equation of vapour pressure on the assumption that the change of volume of the liquid or solid state in the domain considered could be neglected. In the present paper he deduces the equation without this assumption. Entirely mathematical. T. B.

734. *Studies in Vapour Pressure. Part II. The Mononitrotoluenes.* **J. F. T. Berliner** and **O. E. May.** (Am. Chem. Soc., J. 48. pp. 2630–2634, Oct., 1926.)—Using the method employed to measure the vapour pressures and the means employed to calculate the vapour-pressure equations, latent heats of vaporisation and entropies as described in a previous paper [see Abstract 2728 (1925)], the three isomeric mononitrotoluenes are studied from 50° C. to a few degrees above their respective boiling points. The boiling points at atmospheric pressure are given as follows: *o*-nitrotoluene, 220·38° C.; *m*-nitrotoluene, 231·87° C.; *p*-nitrotoluene, 238·34° C. The latent heat equations are derived and the latent heats of vaporisation calculated, the calculated values showing good agreement with observed values. The entropies of vaporisation at a concentration of 0·00507 mole per litre indicate that the molten mononitrotoluenes are normal liquids. A. B. C. L.

735. *The Radiation and Temperature of Luminous Flames.* **H. Senftleben** and **E. Benedict.** (Zeits. techn. Physik, 7. 10. pp. 489–490, Oct., 1926.)—In connection with a discussion on the temperature determination and radiation properties of luminous carbon flames which recently appeared [see Abstract 130 (1926)], the authors give some experimental and theoretical results which they have obtained on a Hefner candle. The candle was exposed to the radiation of an arc lamp and the intensity of the scattered light compared with the incident radiation. Their experiments show that the optical properties of such a flame depend upon the diffraction of the light produced by the carbon particles contained in the flame. It is possible to determine the size of these particles and the number per unit volume. The temperature of the Hefner candle is found to be 1690° absolute. This is determined by introducing into the flame a platinum wire carrying a current. The current is adjusted until no deposit of carbon takes place on the wire. The temperature of the flame is then deduced from the temperature of the wire. W. C. S. P.

736. *Interaction of Radiation with Matter and on Fluorescent Exciting Power.* **E. H. Kennard.** (Phys. Rev. 28. pp. 672–683, Oct., 1926.)—The interaction of radiation and matter is discussed on the basis of Einstein's theory. The distribution of energy in an enclosure containing quantised particles is indeterminate unless there is thermal or other non-radiative interaction between the particles; the latter process is therefore essential to the production of the black-body distribution. Fluorescence cannot lower the entropy of the system. No sharp distinction can be drawn between thermal emission and fluorescence. If ψ_{yx} is the fluorescence of frequency ν_y excited by radiation of frequency ν_x, and if a_x, a_y, u_x, u_y are the corresponding absorption coefficients and black-body densities respectively, then on certain assumptions $\psi_{yx} = ka_xa_yu_y/\nu_x$, k being independent of ν_x and ν_y. Much more general assumptions lead to: $\psi_{yx}/\psi_{xy} = \nu_yu_y/\nu_xu_x$. These equations ought to apply to gas fluorescence, and it is quite possible that the latter may hold generally for liquids and solids and the former in those cases where the shape of the fluorescence band does not vary with the exciting frequency. The equations agree with the few data in exsitence. AUTHOR.

737. *Theory of the Radiometer.* **A. Sterntal.** (Zeits. f. Physik, 39. 5–6. pp. 341–360, 1926.)—In this paper the radiometer pressure upon a single-plate radiometer is calculated, taking into consideration the surface behaviour of the radiometer vane and assuming the gas to be at rest. It is found that the radiometer effect is proportional to the first power of the thermocurrent. The fact that E. Einstein had concluded the proportionality to be as the second power is traced to the circumstance that the presence of solid bodies in the gas was not taken into account. Further, it was established that, with the usual radiometer constructions, the radiometer effect at higher pressures is inversely proportional to the gas pressure to a close degree of approximation. Concerning the direction of the force, it was found for a radiometer vane of a single material that a negative radiometer effect is only possible when the non-radiated side is rougher than the side radiated. The paper is mainly mathematical. H. H. Ho.

738. *The Entropy of Aqueous Ions.* **W. M. Latimer** and **R. M. Buffington.** (Am. Chem. Soc., J. 48. pp. 2297–2305, Sept., 1926.)—The purpose of this paper is to investigate further the relation previously found by Latimer [see Abstract 2472 (1926)], in which approximate proportionality was established between the entropy of solution and the heat of solution of gaseous ions. In addition a survey of existing data has been made from which a table of values for the relative entropies of the more important ions referred to hydrogen has been compiled. Some typical examples are also given to illustrate the tremendous value of such a table of entropies in the simplification of the thermodynamics of solutions. As a standard for comparison the authors adopt the hypothetical one-molal solution at 298° K., and calculate the values initially as the sum of the entropies of equivalent weights of two ions of unlike charge, or the difference in the entropies of equivalent weights of two ions of like charge. A discussion is included on the reliability of values for the ionic entropies. H. H. Ho.

739. *Classical Mechanics and Thermal Radiation.* **A. Smekal.** (Zeits. f. Physik, 40. 1–2. pp. 163–164, 1926.)—This paper is a rejoinder to a similar publication by Klemensiewicz [see Abstract 411 (1927)]. In it the author shows in what sense the contradiction between the Rayleigh-Jean's radiation formula and the radiation properties of actual matter may be capable of explanation. [See also Abstract 2409 (1926).] H. H. Ho.

740. *Molecular Association and the Equation of State.* **M. F. Carroll.** (Phil. Mag. 2. pp. 385–402, Aug., 1926.)—It is illogical to suppose that molecular association is confined to particular substances or particular states. Assuming that for a completely non-associated substance the equation of van der Waals holds rigidly—*i.e.*, a and b are constant and $s = 8/3$—all deviations can be explained by assuming general association. Association thus broadly defined postulates that statistically the time of contact determines the number of molecules in a given volume. Application of this theory to the known critical data for various substances is made, and the results are discussed. G. A. S.

741. *Equation of State of Solid Substances, etc., in Connection with the General Expression for the Energy and the Entropy. Simple Derivation of the So-called Entropy Constant. Part III.* **J. J. van Laar.** (K. Akad. Amsterdam, Proc. 29. 5. pp. 683–698, 1926.)—This paper commences in Part I with a discussion of the general considerations of energy supplementing a previous publication [see Abstract 2909 (1926)]. In § 1 it is proved that in the solid state the T^4 region exists only on the left of a certain line and that for liquids and gases it is always the RT region, even if the temperature (for gases) verges to zero. § 2 then considers in detail the equation of energy and the equation of state in the RT region and § 3 the same for the T^4 region. Part II discusses entropy, §§ 1 and 2 dealing with the T^4 and RT regions respectively. § 3 contains the calculation of ω {the elementary volume $v_{00} - b_{00} = N/e \times h^3/(k\theta_0)^{3/2}(2\pi m)^{3/2}$} from the cyclic movement round the states of equilibrium in connection with the zero-point energy. The paper is mathematical throughout. H. H. Ho.

SOUND.

742. *The Basis of Acoustic Measurements by Reverberation Methods.* **A. H. Davis.** (Phil. Mag. 2. pp. 543–556, Sept., 1926.)—Following a short account of the derivation of the theoretical equations of reverberation and a *résumé* of the experimental laws established by W. C. Sabine, the physical phenomena involved in reverberation measurements are discussed. Conclusions are drawn as to the conditions under which the measurements may be made. The measurement of transmission through partitions by reverberation methods is also considered, both for the case where the transmitted sound is observed just after passing through the partition and for a modification in which it is studied in a reverberant condition in a large room. AUTHOR.

743. *Reverberation Measurement.* **V. O. Knudsen.** (Optical Soc. America, J. 13. pp. 609–612, Nov., 1926.)—Using a thermionic tube oscillator as source, most of the difficulties attending the use of a series of organ pipes are eliminated. A sound of any pitch and of any desired multiple of the minimum audible intensity can be produced in a particular room immediately before reverberation measurements. The absorption coefficients of different materials are readily calculated and the effects of different treatments estimated. G. A. S.

744. *Sound Probing.* **F. Trendelenburg.** (Zeits. f. Hochfrequenztechn. 28. 2. pp. 54–64. 28. 3. pp. 84–91, 1926.)—A discussion of methods and results under the headings: Measurements in a sound field; theoretical treatment of the working of sound receivers; methods of probing; physical properties of speech and musical sounds; influence of distortion upon sound perception. G. A. S.

745. *Recording and Reproduction of Sound.* **S. T. Williams.** (Frank. Inst., J. 202. pp. 413–448, Oct., 1926.)—An account of recent constructional developments in the attempt to obtain faithful reproduction. G. A. S.

746. *Velocity of High-Frequency Longitudinal Waves in a Liquid.* **R. W. Boyle** and **G. B. Taylor.** (Roy. Soc. Canada, Trans. 19. Sect. 3. pp. 197–203, 1925.)—Theory and calculation show that no sensible diminution of the velocity of high-frequency waves in a liquid is to be expected unless the viscosity is very great and the frequency very high. Experiment shows that between the frequencies of 43,000 and 600,000 per sec. in water the diminution is only 5 %, the possible experimental error being 2 %. G. A. S.

747. *Direct Absolute Measurement of Acoustic Impedance.* **G. W. Stewart.** (Phys. Rev. 28. pp. 1038–1047, Nov., 1926.)—The method is based upon the knowledge of the effect of acoustic impedance upon the incident wave when inserted as a branch of an acoustic conduit. With the impedance as a branch the values of its two components can be ascertained by $Z_1 = (\rho a/2S) \,.\, A/(A^2 + B^2)$ and $Z_2 = (\rho a/2S) \,.\, B/(A^2 + B^2)$, where ρ and a are the density of and velocity of sound in the medium, S is the area of the conduit, and A and B are known functions of the incident and transmitted pressure amplitudes and of the difference of phase between them. A common source actuated two telephone receivers, one serving as a source of sound and the other as a comparison instrument. The apparatus was so constructed that the transmitted wave was matched in intensity by one from the comparison receiver. This was done by reducing the effect of the addition of the two waves at the ears to zero. The adjustment enabled the phase relation to be measured at the same time. Illustrations are given of the accuracy obtainable by measuring Z_1 and Z_2 for an orifice, a Helmholtz resonator and an infinite tube. Satisfactory comparisons are made with the theoretical values. The components of a conical horn are also given. The method can be used for any sort of acoustical impedance in a fluid medium, and is simple, direct and accurate. AUTHOR.

748. *Optical Analysis of Sound.* **E. E. F. d'Albe.** (Optical Convention, Proc. Part. II. pp. 894–898, 1926.)—Describes a new method for producing acoustic "spectra" showing the constitution of any composite wave-train of music or speech. The analysis is effected by means of a set of highly selective acoustic resonators, each consisting of a Helmholtz cylinder at the orifice of which is mounted a mica reed carrying a mirror at the free end. The mirror reflects a narrow beam of light on to a screen, and the exact location is obtained by means of a universal joint. "Spectrograms" of speech and music are obtained by moving a film at right angles to the line of spots. AUTHOR.

749. *Optical Problems Relating to "Speaking Films."* **A. O. Rankine.** (Optical Convention, Proc. Part. II. pp. 909–921; Disc., 921–922, 1926.)—This paper deals with past achievements in the production of photographic sound records capable of affording, in conjunction with photoelectric devices, reproduction of the sounds themselves. The optical arrangements for these purposes are discussed in relation to the other requirements of the processes, and details are given of a system, already mentioned briefly in an earlier publication, which the author has used, together with some hitherto unpublished results by this method. Suggestions are made with regard to the directions in which further improvements of an optical character are possible. AUTHOR.

750. *Acoustics of Buildings.* **G. W. C. Kaye.** (Engineering, 122. pp. 605–606, Nov. 12, 638–640, Nov. 19, and pp. 667–669, Nov. 26, 1926. Paper read before the Roy. Inst.)—A summary of present knowledge. Different microphones as sources of pure sounds. Photography of sound waves in models of rooms, geometrical and ripple tank methods, showing the disturbing focussing effects of curved walls, the formation of echoes and the improvements produced by coffering. Reverberation. Measurements of absorbing powers of different lining materials. Methods of sound proofing. G. A. S.

751. *Sound Transmission in the Open.* **E. S. Player.** (Roy. Meteorolog. Soc., J. 52. pp. 351–360; Disc., 361–362, Oct., 1926.)—So many meteorological conditions affect the transmission of sound that it is very difficult to separate out their effects. The only factor whose changes are at all comparable with the great and sudden variations in the range of audible transmission is humidity. G. A. S.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS AND ATMOSPHERIC ELECTRICITY.

752. *Surface Tension of Charged Surfaces.* **O. K. Rice.** (J. Phys. Chem. 30. pp. 1348–1355, Oct., 1926.)—The paper deals with the theory of charged surfaces and the accompanying phenomena. The electrostatics of the surface is treated mathematically and compared with the thermodynamic expression. The kinetics of the adsorbed ions is developed by aid of the Boltzmann probability principle. F. J. B.

753. *Lichtenberg's Figures.* **W. P. Allis** and **H. Müller.** (J. Math. Phys. Mass. Inst. of Technology, 6. No. 1. pp. 62–68, Nov., 1926.)—The variations in the size of Lichtenberg's figures are studied in terms of the potential of the impulse, the thickness of the dielectric, and the diameter of the electrode. No theory is propounded. G. A. S.

754. *Measurement of Space Charges in the Free Atmosphere.* **H. Benndorf.** (Phys. Zeits. 27. pp. 576–578, Sept. 1, 1926.)—Points out that in measuring space charges by the cage method the result obtained depends on the material of the cage and of the potential "probe," dropping electrode or polonium probe. Owing to the potential difference between the materials of the cage and the probe a space charge will be indicated when none really exists. Details are given of the values of the error for different materials, and the measurements of Kähler at Potsdam and of Dorno and Kähler at Davos are examined from this point of view. It is shown that it is probable that the marked differences between the results obtained by these observers throughout the year and those arrived at by other observers using other methods are due to this cause. H. N. A.

755. *Preliminary Comparison of Atmospheric Electric Potential at Sea with that under Closely Similar Insular Conditions at Apia, Western Samoa.* **A. Thomson.** (Terrest. Magn. 31. pp. 113–120, Sept., 1926.)—Observations were made at a special house over a lagoon, the house being exposed to winds, but shielded from the waves. Simultaneous records were taken at a station in the observatory grounds. Results were examined when (1) negative electricity only and (2) positive electricity only were present at both stations and simultaneous and complete records existed while curves exhibit the diurnal changes for each. For negative electricity the frequency at the lagoon house is only 0·8 of that at the land station, while the hours of maximum frequency are those when rain is most frequent. Thus negative electricity does occur with showers at sea, but not necessarily with thunderstorms. The effects of positive electricity on land operate at least a short distance out to sea, while the daily curve shows two maxima in contrast with the single maximum found on the *Carnegie* cruises. The frequency of positive electricity on land is 0·49 of that over the lagoon. R. S. R.

DISCHARGE AND OSCILLATIONS.

756. *Sending out Sparks.* **F. A. Fischer.** (Zeits. techn. Physik, 7. 10. pp. 490–492, 1926.)—A theory of sending out sparks and a method of compensation are here described. The analogy with the deviation theory of the magnetic compass is shown. A. E. G.

757. *Development of the Arc Discharge.* **R. Seeliger.** (Phys. Zeits. 27. pp. 730–732, Nov. 15, 1926. Paper read before the Deut. Naturforscher u. Ärzte, Düsseldorf, 1926.)—A discussion is given of the differences between and the similarities of the glow and arc discharges in discharge tubes. It is pointed out that the only fundamental difference between the two is in the phenomena at the kathode. The development of the arc discharge from the glow discharge is discussed and experimentally investigated in a special discharge tube with the kathode a mercury surface at the end of a small quartz tube, the discharge tube being filled with nitrogen or one of the rare gases. [See Abstract 1421 (1926).] A. W.

758. *Temperature of Gases in Discharge Tubes.* **R. Seeliger.** (Phys. Zeits. 27. pp. 732–733, Nov. 15, 1926. Paper read before the Deut. Naturforscher u. Ärzte, Düsseldorf, 1926.)—The methods of investigating the temperatures in discharge tubes (*a*) by the use of thermoelements and (*b*) using the discharge tube itself as a gas thermometer, are discussed and experiments are described with a specially constructed tube. The arrangement was quite symmetrical. Some of the thermoelements were encased in very thin glass: others were introduced bare. In the latter case great attention had to be paid to insulation. The best arrangement appears to be with the enclosed thermoelements. With these the temperature determinations in the rare gases agree, within the errors of experiment, with manometric measurements, and it appears that temperatures can be determined accurately to within about 1°. In hydrogen there appear to be systematic discrepancies which depend on the kind of thermoelement used and on the degree of dryness of the gas. A possible explanation is to be found in dissociation effects. A. W.

759. *Conductivity of Flames.* **E. Marx.** (Phys. Zeits. 27. pp. 697–701, Nov. 1, 1926. Paper read before the Deut. Naturforscher u. Ärzte, Düsseldorf, 1926.)—This paper is in the main mathematical. The author makes use of the knowledge, so far obtained on the conductivity of flames, in the discussion of formulæ and general conclusions. A. E. G.

760. *Passage of Electricity between Platinum Electrodes in a Vacuum.* **H. Rohmann.** (Zeits. f. Physik, 39. 5–6. pp. 427–436, 1926.)—In a previous paper [see Abstract 2167 (1926)] the author stated that the critical field strength for the setting-up of a discharge between platinum electrodes in a vacuum experiences a remarkable alteration when the electrodes are brought into contact with a relatively small resistance. After separation the critical field strength was found to be essentially decreased for the same direction of current as at contact; for the opposite direction it was increased. It is now found that the field strength for a discharge in a vacuum between platinum-iridium electrodes reaches a

value under 20,000 volts/cm. by bringing the glowing electrodes into contact. The properties of the discharge are more closely investigated.
A. E. G.

761. *Atomic Variation in Processes at the Surface of the Glow Kathode.* **W. Schottky.** (Phys. Zeits. 27. pp. 701–704, Nov. 1, 1926. Paper read before the Deut. Naturforscher u. Ärzte, Düsseldorf, 1926.)—The author has previously attempted to analyse more closely the so-called Schrot effect in connection with the variation phenomena which may be expected with the glow emission. The present paper is of a theoretical nature in which the results obtained by others, in particular by Johnson, are considered. A. E. G.

762. *Influence on the Normal Kathode Fall of Small Additions of Alkali or Alkaline Earth to Mercury.* **A. Güntherschulze.** (Zeits. f. Physik, 39. 7–8. pp. 491–494, 1926. From the Reichsanstalt.)—It is here shown that the addition of a thousandth part per cent. of alkali or alkaline earth to mercury lowers the normal kathode fall in mercury quite considerably. It is, therefore, pointed out that when exact measurements are required, very particular attention must be given to this dependence of the normal kathode fall upon the material of the kathode.
A. E. G.

763. *Theory of the Kathode Dark Space.* **R. Seeliger.** (Zeits. f. Physik, 39. 7–8. pp. 601–602, 1926.)—Two theories have been advanced to account for the kathode dark space phenomena. The first of these, which may briefly be called the " field " theory, since the strength of the electric field in the dark space region plays the principal part, assumes that a part of the light emission in the kathodic discharge arises from recombinations between electrons and positive ions and that this recombination is hindered in the space immediately in front of the kathode by the strong field existing there. According to the second theory, which may briefly be called the " excitation " theory, the light on the discharge is due principally to electron collisions and the dark space is explained by the different forms of the excitation functions for the individual frequencies. From a discussion of experimental work it seems that the " field " theory is more in accord with facts, though there are still several outstanding difficulties requiring satisfactory explanation. A. W.

764. *Theory of Collectors in Gaseous Discharges.* **H. M. Mott-Smith** and **I. Langmuir.** (Phys. Rev. 28. pp. 727–763, Oct., 1926.)—When a cylindrical or spherical electrode (collector) immersed in an ionised gas is brought to a suitable potential, it becomes surrounded by a symmetrical space-charge region or " sheath " of positive or of negative ions (or electrons). Assuming that the gas pressure is so low that the proportion of ions which collide with gas molecules in the sheath is negligibly small, the current taken by the collector can be calculated in terms of the radii of the collector or sheath, the distribution of velocities among the ions arriving at the sheath boundary and the total drop of potential in the sheath. The current is independent of the actual distribution of potential in the sheath provided this distribution satisfies certain conditions. General formulæ for the current are derived, and the calculations are then carried out for collectors in a group of ions having velocities which are (*a*) equal and parallel ; (*b*) equal in magnitude, but of random direction ; (*c*) Maxwellian ; (*d*) Maxwellian with a drift velocity superimposed. General equations are also given by means of which the velocity distribution can be calculated directly from the volt-ampere characteristics of a sphere or cylinder. The special properties of Maxwellian distribution are considered, and the effect of reflection of ions at the collector surface in modifying currents calculated by the given equations is discussed.

A. E. G.

765. *Normal Arc Characteristic Curves. Dependence on Absolute Temperature of Anode.* **W. B. Nottingham.** (Phys. Rev. 28. pp. 764–768, Oct., 1926.)—The equation $V = A + (B/I^n)$ for normal arc characteristic curves has been verified and the temperature range over which n has been found to be proportional to the absolute temperature of the boiling point of the anode material has been extended to include the zinc arc in argon at 1180° K. with 0·345 for n and the tungsten arc in air at approximately 5100° K. with $n = 1{\cdot}38$.

A. E. G.

766. *Excitation Potential of Mercury Atoms.* **R. G. Loyarte.** (Phys. Zeits. 27. pp. 584–588, Sept. 15, 1926.)—The work of Franck and Einsporn on the excitation and ionisation potentials of mercury atoms is first considered and their results are presented in tabular form. As the result of the present investigation it is suggested that it is possible Hg may play an abnormal rôle, as has already been observed for its neighbour thallium, in the periodic series.

A. E. G.

767. *Ionisation Potentials of Nitrogen and Hydrogen on Iron and Other Metals.* **G. B. Kistiakowsky.** (J. Phys. Chem. 30. pp. 1356–1363, Oct., 1926.)—An experimental method for determining the positive ion current produced by slow electron impacts on metal surfaces is developed. The results show that on nickel, iron, copper and platinum the positive ionisation starts at 11 and 13 volts. For other metals the values are slightly different, but the differences are not much larger than the possible experimental error. Special experiments lead to the conclusion that the ionisation at 11 volts belongs to nitrogen adsorbed in the metal surface, that at 13 volts to the adsorbed hydrogen. A theoretical proof is given that the ionisation at 11 volts cannot possibly belong to molecular nitrogen, and is due to an excited molecule or a nitrogen atom. Reasons for favouring the latter conclusion are given. The work of Wolfenden [see Abstract 1712 (1926)] is critically examined, and his results are in agreement with the experimental results of the investigation.

F. J. B.

768. *Thermionic Emission of the Metals Tungsten, Molybdenum, Thorium, Zircon and Hafnium.* **C. Zwikker.** (K. Akad. Amsterdam, Proc. 29. 6. pp. 792–802, 1926.)—It is found that the metals tungsten, molybdenum, thorium and, according to Dushman, tantalum yield a value for A in the formula $i = AT^2 10^{-b/T}$ which is in accordance with the theoretical value, perhaps slightly modified by the Thomson effect. The values which zircon and hafnium give depart, however, greatly from it. Dushman observed that greatly divergent values of A do occur. In this case there is always a question of a thin layer of emitting substance on the metal filament. He also states that A will always become greater than the theoretical value when the covering layer is electronegative. This view helps to account for the high values which zircon and hafnium give. A. E. G.

769. *The Effect of a Hydrogen Atmosphere on the Velocity Distribution among Thermionic Electrons.* **C. del Rosario.** (Phys. Rev. 28. pp. 769–780, Oct., 1926.)—The thermionic current from a tungsten or platinum filament to a coaxial cylindrical electrode was measured for different retarding potentials first in vacuum and then in hydrogen, keeping the temperature of the filament constant. The heating current was made intermittent to eliminate the magnetic field and the potential drop along the filament when the thermionic current was being measured. The filament temperature was kept constant to 1/10 % by a Wheatstone bridge arrangement of which the filament was made one arm. Filament temperatures ranging from 1520° K. to 1990° K., and pressures of hydrogen from 0 to 0·25 mm. Hg were used The distribution of velocities among the electrons in vacuum and in hydrogen was found to follow Maxwell's law; and, contrary to the experience of former observers, the temperature calculated from the Maxwellian distribution was found to be the same for the case of a vacuum as for that where hydrogen was present to an accuracy higher than 0·7 %, which is within the accuracy of the experimental data. Moreover, the temperature so calculated was for all cases in close agreement with the filament temperature estimated from data of Forsythe and Worthing for tungsten and those of Pirrani for platinum. The maintenance of thermal equilibrium between the electrons and the filament in hydrogen suggests the elastic nature of the collisions between the electrons and the hydrogen molecules. AUTHOR.

770. *Theory of the Maintenance of Short Electric Waves generated with Triodes.* **D. Nukiyama, Y. Toda** and **T. Yata.** (Phys. Math. Soc. Japan, Proc. 8. pp. 144–159, July, 1926. In English.)—The circuit arrangement employed in the investigation described here is similar to that used by Barkhausen [see Abstract 908 (1920)], in which two Lecher wires connected to the valve grid and anode respectively are shorted by a variable condenser which can slide along them. The wave-lengths generated are measured on another Lecher wire system. The dependence of the wave-length on various factors is investigated, and the results are discussed in their bearing on the theories of Whiddington, Schottky and Gill, and of Sahánek [see Abstract 2145 (1925)]. The results show, so far as they go, that the equation $\lambda = BT$ holds good, λ being the wave-length, B a constant and T the time needed by an electron to travel a distance $d - a$ from the grid, a being the radius of the grid helix and d the distance from the grid at which the electrons which cross the grid reverse their direction and return to the grid (assuming no disturbing field). A. W.

771. *Reflection of Hertzian Waves by Magnetic Wire Grids.* **W. Arkadiew.** (Ann. d. Physik, 81. 7. pp. 649–665, Nov. 5, 1926.)—Theory is given relative to the reflection of short electric waves by grids formed of wires of ferromagnetic material. From the formulæ derived it is possible to calculate the magnetic properties of the materials for high-frequency oscillations. The values thus obtained for the permeability and conductivity, using the results of measurements of the absorption of electric waves by nickel and iron wire grids, are in agreement with curves derived from the theory of magnetic dispersion. A. W.

772. *Direction Phenomena through "Field Decay" and "Kippschwingungen" in Electron Tubes.* **E. Friedländer.** (Zeits. techn. Physik, 7. 10. pp. 481–484, 1926.)—In this paper the emission of secondary electrons is considered and their availability for generation of "Kippschwingungen" is developed. [See also Abstract 455 (1927).] A. E. G.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

773. *The Hall Effect in Bismuth Sputtered Films.* **T. F. Hargitt.** (Phys. Rev. 28. pp. 1034–1037, Nov., 1926.)—The Hall e.m.f. in sputtered bismuth films ranging in thickness from 10^{-5} to 10^{-4} cm. was measured. The Hall coefficient was calculated from the usual formula $R = Et/Hi$, and the values of R plotted against the thickness of the film. The curve shows a general increase in the value of R from 2×10^{-5} e.m.u. for a thickness of 10^{-5} cm. to about 16×10^{-5} cm. for a thickness of 10^{-4} cm. Three films were sputtered in a magnetic field. Two of these give values of R about 75 % higher than for the other films of the same thickness, while the third gave a value nearer that for films sputtered in the absence of a magnetic field. This latter result is less determinate, however, because of the thinness of the film and the consequent smallness of R. AUTHOR.

774. *The E.M.F. of the Thermoelectric Couples Tungsten-Tantalum and Tungsten-Molybdenum at Very High Temperatures.* **S. Morugina.** (Zeits. techn. Physik, 7. 10. pp. 486–489, Oct., 1926.)—A vertical tungsten filament and a horizontal filament of tantalum were fixed into the base of a kathode lamp so as to form a cross, the centre of which served as the thermoelectric junction. Each wire could be heated by a battery, and was connected to a potentiometer for the measurement of the thermoelectric e.m.f. In order to secure uniform heating of the tungsten wire a direct vision prism was utilised and the temperature was ascertained on the Langmuir scale. The measurements were carried out *in vacuo* up to 2430° C., after which a number of determinations were made at lower temperatures with the same couples enclosed in a quartz tube (not evacuated), the temperatures being measured by platinum-nickel couple. The values obtained by the two methods agree well in the region of 1000° C. The author's results agree with the Landolt tables up to 400° C., but beyond that temperature there are differences which cannot be explained. The author's experiments on the tungsten-molybdenum couple show that the e.m.f. vanishes at 1900° C., and is comparatively small at all temperatures. His results differ from those of Rohn. W. C. S. P.

775. *The Phenomena of Excitation in Crystals which Absorb Light.* **Z. Gyulai.** (Zeits. f. Physik, 39. 9. pp. 636–643, 1926.)—Investigates the temperature effect on the "excitation" of yellow rock-salt when illuminated, and the spontaneous disappearance of the excitation at different temperatures. With one exception the excitation was measured by purely optical methods. The results explain why the maximum excitation of crystals shows itself within wide limits to be independent of the intensity of the exciting illumination, and agree well with Gudden and Pohl's view that the excitation depends on photoelectric disturbances of the crystal lattice [see Abstract 2691 (1926)]. In conclusion, a short reference is made to the connection between the general case of excitation and the special case of crystal phosphorescence. H. N. A.

776. *Photoelectric Action in Natural Blue Rock-Salt.* **R. Hilsch** and **R. Ottmer.** (Zeits. f. Physik, 39. 9. pp. 644–647, 1926.)—Gyulai recently measured the photoelectric conductivity of the above substance for wave-lengths between 250 and 700 $m\mu$ [see Abstract 989 (1926)], and concluded that the effect observed was due to a selective photo effect of the minute sodium particles embedded in the crystal lattice which have been observed by Siedentopf with the ultramicroscope. The authors have extended the observations to include the whole interval from 186 to 2000 $m\mu$, and their results confirm those of Gyulai, and show that for very short wave-lengths the quantity of electricity per unit of absorbed light energy rises to a high value. There appears to be a minimum value for about $\lambda = 230\ m\mu$, the Gyulai maximum lying at about 320 $m\mu$. The curves resemble so closely those obtained by Farwig for the surface photo effect of compact alkali metals that there can be little doubt that they can be explained by the superposition of a selective and a normal surface photo effect of the small imprisoned sodium particles.
H. N. A.

777. *Photoelectric Phenomena.* **B. L. Rosing.** (U.S.S.R. Sci. Techn. Dept. Moscow, No. 147. pp. 9–10, 1926. In German.)—The theory of photoelectric phenomena only gives experimentally demonstrable results by the employment of the quantum theory. The author shows that the general solution of the equations of the electromagnetic field (law of the retarded and advancing potential) instead of the partial solution given by Lorentz (law of the retarded potential) alone affords a rational explanation of the first postulate of Bohr, namely the non-radiation of light energy with a closed stationary path of the electron. In the same way is given the explanation of the second postulate, namely the existence of stable paths of the electron subject to the law of the quantum numbers.
J. J. S.

778. *Compound Photoelectric Effect.* **P. Auger.** (Ann. de Physique, 6. pp. 183–253, Sept.–Oct., 1926.)—An account is given of a study by the Wilson expansion chamber method of the compound photoelectric effect for X-radiation. The photographs obtained with the Wilson apparatus, in which an X-ray pencil is passed through one of the rare gases suitably diluted with hydrogen, show quite clearly, in addition to the β-ray tracks corresponding to true photoelectrons, other so-called tertiary β-ray tracks which are attributed to electrons expelled in the readjustment of the atom after the departure of the photoelectron. The lengths of these tracks are independent of the frequency of the exciting X-rays, but are characteristic of the atoms of the rare gas in which they are produced. Furthermore, certain branch tracks of actual photoelectron tracks are explained as due to atoms ionised by collision with the photoelectron which readjust by expelling tertiary β-rays. By a statistical study of the photographs the author is able to calculate for each of the rare gases the "fluorescence yield," *i.e.*, that fraction of the total number of atoms which have lost an electron in the K- or L-ring, for which readjustment occurs by emission of characteristic X-rays. Comparative measurements were also made of the ranges of the tertiary β-rays obtained from the different atoms in mixtures of the rare gases. Assuming Whiddington's fourth power law relating range to velocity, and using values for the energy levels of the atoms of the rare gases in accordance with Moseley's law, the relative emission velocities of the tertiary β-rays observed were found to agree well with the calculated values. A final section of the paper is devoted to a correlation of the results obtained with allied phenomena of radioactivity and fluorescence, and some general notions of a theoretical character are advanced. W. S. S.

779. *Electrostriction in Gases.* **W. Kliefoth.** (Zeits. f. Physik, 39. 5–6. pp. 402–414, 1926.)—In this investigation the electrostriction effect is experimentally established for the dipole gases CO_2 and SO_2 and also for air, oxygen and nitrogen. In the case of CO_2 and SO_2 a finite value has been found for the electric moment, while for air, oxygen and nitrogen no value for the moment differing from zero has been afforded. For tensions exceeding 15,000 volts there is a considerable deviation in the experimental results from those calculated on the Gans-Debye-Frivold theory. This is traced to a dependence of the dielectric constant on the electric field. Full experimental details are included. H. H. Ho.

780. *Dielectric Constants of Diatomic Dipolar Gases According to Wave Mechanics.* **C. Manneback.** (Phys. Zeits. 27. pp. 563–569, Sept. 1, 1926.)—This is purely a mathematical paper starting from Debye's equation $M = \frac{3}{4\pi} \cdot \frac{\epsilon - 1}{\epsilon + 2} F = N\left(y + C\frac{\mu^2}{kT}\right)F$, where M is the polarisation, F an inner electric field, $C = \frac{1}{3}$, N is the number of molecules per unit volume, k is the Boltzmann universal constant. Only those gases with rigid molecules far enough removed from the critical condition are considered. A. E. G.

781. *Influence of Gas Charge on the Electrical Resistance of a Wire. Part II.* **T. Sexl.** (Zeits. f. Physik, 39. 5–6. pp. 334–336, 1926.)—This paper supplements a previous publication [see Zeits. f. Physik, 32. 333, 1925], and records consequences from the Lorentz theory of the electrical and thermal conductivity in metals with respect to the influence which gas charge exerts on both conductivities. Further, it is established that the measurements of the Wiedemann-Franz number are not invalidated by the gas charge at least for the two conductivities of the same gas-charged state. H. H. Ho.

782. *Temperature Sensitivity of the Dielectric Constants of CH_4, CH_3Cl, CH_2Cl_2, $CHCl_3$, CCl_4 in Vapour Form.* **R. Sänger.** (Phys. Zeits. 27. pp. 556–563, Sept. 1, 1926.)—The experimental basis of Debye's theory for the temperature sensitivity of the dielectric constants by experiments on CH_4, CH_3Cl, CH_2Cl_2, $CHCl_3$, CCl_4 is extended, and the possibility of employing vapours is proved. The symmetrical atomic structure of CH_4 is strongly disturbed through the exchange of a H-atom with a Cl-atom next by the transition to methylchloride; but, on the other hand, the asymmetry diminishes with methyline chloride and chloroform and after all the H-atoms are replaced by Cl-atoms leads in the case of carbon

tetrachloride to molecular symmetry. The electric dipolar moment thereby appearing of the asymmetrical molecule is found to be: CH_3Cl, $\mu = 1{\cdot}9_7 \,.\, 10^{-18}$; CH_2Cl_2, $\mu = 1{\cdot}5_9 \,.\, 10^{-18}$; $CHCl_3$, $\mu = 0{\cdot}9_5 \,.\, 10^{-18}$.
A. E. G.

783. *Dielectric Constants of Dilute Aqueous Electrolytes.* **H. Hellmann** and **H. Zahn.** (Phys. Zeits. 27. pp. 636–640, Oct. 15, 1926.)—The lowering of the dielectric constant of water by very low concentrations of potassium chloride is measured by a resonance method of Drude employing a wave-length of 106 cm. and a sensitive thermoelement as detector. The values are found to be much lower than has been estimated in recent work. The results of Walden, Ulick and Werner who employed a wave-length of 450 cm. are critically examined, and their experimental procedure is carefully repeated. It is concluded that errors may arise from regarding the high frequency system as a quasi-stationary one, the resistance of the measuring circuit is affected by the presence of the adjacent thermocouple, while an unascertained error may be expected from the influence of the conductivity of the electrolyte on the inductivity and resonance position with the parallel arrangement of electrolyte and measuring condenser employed. The main cause of discrepancy is found to be due, however, to the influence of the form and size of the condenser and the nature of the coupling between the oscillating and the resonance circuits. The results of Walden, Ulick and Werner are reproduced when their conditions of measurement are copied, but by employing a more loosely coupled circuit while a crystal detector is used to obtain greater sensitiveness, the values differ, and at very low concentrations of salts no perceptible change in the position of resonance from the values for pure water is observed. The effect obtained when employing the modified Drude method is also very small and of a similar magnitude to that obtained by extrapolation of the decrement method. At higher concentrations the dielectric constant increases as found by others, and for certain salts the value for pure water is exceeded. [See Abstract 2440 (1926).] J. N. P.

784. *Lack of Effect of a Magnetic Field on the Dielectric Constant of HCl and NO.* **L. M. Mott-Smith** and **C. R. Daily.** (Phys. Rev. 28. pp. 976–979, Nov., 1926.)—Recent theoretical investigations by Debye [see Abstract 1667 (1926)], Ruark and Breit, and others have made it of interest to look for a change in the dielectric constant of a gas when a strong magnetic field is applied to it. Weatherby and Wolf, working with helium, oxygen, and air, found that the dielectric constant of these gases does not change by more than one part in half a million when the gas is put into a magnetic field of 10,000 gauss. Using an electron tube method, the present authors tested whether the dielectric constant of HCl and NO gases change when a strong magnetic field is applied. The magnetic field strength used was 4800 gauss, and the apparatus was capable of definitely detecting a change in the dielectric constant of one part in 100,000. The gases tested were at pressures of from about 2 to 40 cm. of Hg, at room-temperature, and with the magnetic field both parallel and perpendicular to the electric field. No change was detected under any conditions. A. E. G.

785. *Shielded Non-Inductive Resistances.* **L. Hartshorn** and **R. M. Wilmotte.** (Journ. Sci. Instruments, 4. pp. 33–37, Nov., 1926.)—The residual inductance of a "non-inductive" resistance coil of high value (10,000 ohms or more) changes appreciably with changes of its capacity to earth, and thus it is necessary to shield such coils in precision work. The coil thus becomes a three-terminal device, and it is necessary to define exactly what is meant by its impedance. It is shown that in practice there are three possible values for the impedance of any coil, which are important in bridge and many other measurements. The effect on these values of the capacity to screen is pointed out, and a simple equivalent network for the coil is indicated. AUTHORS.

786. *A Potential Multiplier for Direct Currents.* **B. L. Rosing.** (U.S.S.R. Sci. Techn. Dept. Moscow, No. 147. p. 10, 1926. In German.)—In the apparatus described for raising the potential the low tension is continuously conveyed to one after another of a series of condensers by means of rotating brushes, and thus at the end of the series a high potential exists which is equal to the low potential multiplied by the number of the condensers. This potential multiplier has worked well during a year whilst used with kathode oscillographs and high-tension vacuum apparatus. J. J. S.

ALTERNATING CURRENTS AND MAGNETISM.

787. *A Case of Coupled Circuits.* **R. M. Wilmotte.** (Phil. Mag. 2. pp. 1098–1108, Nov., 1926.)—In certain circumstances two syntonised coupled circuits become nearly equivalent to a four-arm bridge. In these cases general formulæ for the circuits can be found, and the conditions deduced under which the circuits have only one resonant frequency. Experimental verification of the theory is obtained. G. A. S.

788. *Investigations of the Magneto-Electric Direction Effect.* **A. Huber.** (Phys. Zeits. 27. pp. 619–627, Oct. 15, 1926.)—For the derivation of the Currie law of the temperature dependence of paramagnetism, Langevin has put forward the conception that a paramagnetic molecule possesses a rigidly bound magnetic moment whereby on imposition of an external magnetic field the molecules tend to set with their magnetic axes, depending on the extent of the temperature movement, in the direction of the field. If paramagnetic molecules, which also possess an electric moment, be introduced into a constant magnetic field, an electrical polarisation should occur which would fail only when the moments are at right angles. It should be possible, therefore, to direct such molecules electrically by a constant magnetic field as also magnetically by a constant electric field. Positive results, however, could not be obtained by Perrier for solids or Szivessy [see Abstract 50 (1926)] for anisotropic liquids. The present investigation describes experiments with full details, and accompanied by the relevant theoretical treatment for gaseous nitric oxide, ferric chloride, liquid nitric oxide, several solid salts, and enantiomorphous crystals, with, however, negative results. After a discussion of the data, the author concludes that the original Langevin theory is much more applicable to the case of para-electricity than to that of paramagnetism. H. H. Ho.

789. *Single Iron Crystals. Part II. Magnetisation. Hysteresis and Rigidity.* **W. Gerlach.** (Zeits. f. Physik, 39. 5–6. pp. 327–331, 1926.)—

In this paper it is shown that the results previously obtained [see Abstract 482 (1927)] by the magnetic investigation of single crystals, which enabled exceedingly fine changes in the interior of crystals to be established, afford a means for the explanation of changes brought about in the cold working of iron. H. H. Ho.

790. *Magnetic Processes Free from Hysteresis.* **Elsbeth Spuhrmann.** (Zeits. f. Physik, 39. 5–6. pp. 332–333, 1926.)—The proposition that the small magnetic changes of state which led to the introduction of the idea of reversible permeability take place without the irreversible development of heat, has been recently doubted by Gumlich and disputed by Uller [see Abstract 2959 (1926)]. It is now shown that by suitable diminution of the field changes of a magnetic cycle the hysteresis may be so lowered that the above changes of state may be regarded as reversible to a sufficient degree of accuracy. H. H. Ho.

791. *A Note on W. Vogel's Paper "Initial Magnetic Permeability."* **O. v. Auwers.** (Phys. Zeits. 27. pp. 724–725, Nov. 15, 1926.)—W. Vogel has asserted [see Abstract 223 (1927)] that a small initial permeability is bound up with a large coercitive force and small maximum permeability, and that large initial and maximum permeabilities are incompatible. Reasons, with graphical illustrations, are given in this note against Vogel's proposition. H. H. Ho.

792. *Effect of Silicon on the Magnetic Properties of Steels.* **K. Daeves.** (Zeits. Elektrochem. 32. pp. 479–481, Oct., 1926. Paper read before the Deut. Bunsen. Gesell., Stuttgart, May, 1926.)—The effect of silicon on steel has been the subject of research since 1899 [see Abstracts 1679 (1900) and 2177 (1901)], the results of Paglianti still holding in respect to their main features [see Abstract 1270 (1912)]. Gumlich has described the part played by silicon [see Abstract 210 (1919)], and the author found that, other things being the same, the watt losses in steel were much influenced by the size of the grain. In contrast to pure iron, the refinement in texture usually caused by the α/γ transformation is not obtained when the material contains over 1·3 % Si. Oberhoffer considered that with increasing Si content the lines of the δ/γ and the α/γ changes approached and ultimately coalesced. This view has been verified in some degree by Wever and Giani. The mechanism of the effect of coarse grains on watt losses is not yet established; the author's view is that the interruption of the magnetic flux at the boundary of the grain causes a rise in the losses. G. E. A.

793. *Magnetic Susceptibilities of Air, O_2, N_2, CO_2, and H_2.* **G. W. Hammar.** (Nat. Acad. Sci., Proc. 12. pp. 594–596, Oct., 1926.)—Measurements of the volume susceptibilities of the above gases are given in the form of graphs, air at 24·5° C. and 76 cm. pressure being taken as the standard. The values are, for all the gases, directly proportional to the pressure or density, *i.e.*, to the number of molecules present. This holds for all pressures from the lowest up to atmospheric pressure, and the results are in agreement with those of Lehrer [see Abstract 485 (1927)]. G. E. A.

794. *Possible Explanation of the Glaser Effect.* **G. W. Hammar.** (Nat. Acad. Sci., Proc. 12. pp. 597–598, Oct., 1926.)—The effect obtained by Glaser [Abstract 607 (1925)] of a change in the dependence of susceptibility on pressure at low pressures in the gases H_2, N_2 and Co_2, is found by the author to be caused by an adsorbed layer of water on the test body. [See preceding Abstract.] G. E. A.

795. *Magnetisation with Very Weak Oscillating Fields.* **R. G. Loyarte.** (Univ. Nac. La Plata, Estudio Ciencias Ser. Mat. Fis. 73. pp. 23–34, Aug., 1926.)—The problem of the magnetisation of ferromagnetic bodies in very weak oscillating fields is theoretically examined, starting from the assumption that these bodies are built up of elementary magnets capable of revolving about the position of rest under the influence of an external field and taking into consideration their mutual impacts. It is postulated that the external field is very small relatively to the molecular field, that the angles of derivation produced in the elementary magnets by this field or by the impacts are very small, and that the number of impacts per second is small relatively to the frequency of the oscillations. It is shown that the dependence of the permeability on the frequency does not, as contended by Page, suffice to explain the measurements established by Wwedensky and Theodortschik [see Abstract 1987 (1923)]. Entirely mathematical. E. F.

796. *Some Special Methods for Magnetic Measurements.* **W. Steinhaus.** (Zeits. techn. Physik, 7. 10. pp. 492–500, 1926.)—Methods are described, more particularly applicable in commercial practice, for the measurement of such magnetic quantities as initial permeability, retentivity and coercive force. They are in general applicable to materials which yield unusual values for such quantities, or which have to be tested in unusual shapes. Some typical results are given, and the sources of error and their correction are considered. Reference is made to what is regarded as a new type of magnetic effect observable in iron in weak fields. It is referred to as "temporal disaccommodation," and seems to have some relation to ageing and viscosity. A. A. D.

797. *Relation between the Activity of the Sun and of the Earth's Magnetism.* **L. A. Bauer** and **C. R. Duvall.** (Terrest. Magn. 31. pp. 97–101, Sept., 1926.)—The annual variation of magnetic activity is investigated with the aid of various measures, chief of which is a quantity F giving the number of days per month of magnetically disturbed days from 1906 to 1924. The average number of such days per month during the sunspot minimum years was 4·4, and about 10 during years of sunspot maximum. During a solar cycle there may be on the average about 7 disturbed days per month. For the period 1906–1924, F showed maxima values (about 9·2 days) in the equinoctial and minima values (about 5·8 days) in the solstitial months. This marked change in F from month to month cannot be successfully correlated with varying sunspottedness during the year. The correlation coefficient between F and the cosine of the sun's declination is + 0·95, and that between F and the sun's heliographic latitude is 0·82. A. A. D.

798. *Micromagnetic Oscillations as Observed at the Observatory of Irkutsk* (*Zouy*) *in* 1925. **A. Pödder.** (Terrest. Magn. 31. pp. 103–112, Sept., 1926.)—Two types of micro-disturbance have been examined. The first type consists of a very regular vibration of the magnet extending over many hours and with a period of 5 to 14 seconds. The second type is more irregular with a period of about 34 seconds. By means of specially refined apparatus the disturbance can be shown in the horizontal and vertical components, as well as in the declination. In each type the amplitude of the disturbance increases with the period. They seem to show some correlation with the microseisms observed by Galitzin. Concerning the diurnal frequency of occurrence, the waves of short period particularly appear during the day (12 h.–19 h. local mean time). At night the waves of longer period appear. Thunderstorms or rain affect the waves of longer but not the waves of shorter period. As far as the annual variation is concerned the amplitudes of both types increase in winter and diminish in summer. A. A. D.

RADIOGRAPHY AND ELECTROPHYSIOLOGY.

799. *Use of the Photographic Densitometer in Radiography.* **J. T. Norton** and **B. E. Warren.** (Optical Soc. America, J. and Rev. Sci. Inst. 13. pp. 525–530, Oct., 1926.)—The examination of radiographic negatives with a photographic densitometer has shown that it is possible to determine the size of a discontinuity in the material with considerable precision from the densitometer readings. A densitometer of the thermoelectric type was used, and it is shown theoretically that the galvanometer deflections are connected by a definite relation which is independent of total thickness of the material. The minimum variation in thickness which can be detected by this method has been determined for some of the common metals. AUTHORS.

800. *The German Unit of the Röntgen-Ray Dose.* **H. Behnken** and **R. Jaeger.** (Zeits. techn. Physik, 7. 11. pp. 563–570, 1926. From the Reichsanstalt.)—Some years ago the following unit was adopted in Germany: The absolute unit of Röntgen radiation (1 Röntgen or 1 R) is the energy which, radiating into 1 cm.^{3} of air at 18° and 760 mm., produces with the full utilisation of the electrons formed and the elimination of all wall-effects, an electric conductance such that the quantity of electricity of the saturation current amounts to one electrostatic unit. In France I. Solomon had already in 1921 proposed a definition for a unit 1 R, *viz.*, the intensity of a Röntgen radiation which produces the same ionisation as 1 gramme of radium at a distance of 2 cm. from the ionisation chamber after filtering the rays through 0·5 mm. of platinum [see Abstract 1397 (1922)], but this unit was unknown at the time in Germany. The authors point out that this unit is indefinite without a specification of the size, shape and material of the ionisation chamber. They test ionisation chambers in use in Germany with the compressed-air chamber of Behnken [see Abstract 861 (1924)] in its various modifications, the larger barrel-chamber of Holthusen and Gaertner, and the air-wall chamber of Fricke and Glasser, which they find to be in accord within 1 or 2 %. They conclude that the proposal of Solomon, further specified as stated, would be acceptable if a suitable material for an air-wall chamber could be found. H. B.

801. *The Mekapion Self-Controlling Röntgen-Ray Dose-Counter.* **S. Strauss.** (Zeits. techn. Physik, 7. 11. pp. 577–582, 1926. Paper read before the Deut. Naturforscher u. Ärzte, Düsseldorf, 1926.)—The instrument measures the instantaneous intensity of a Röntgen radiation, indicates how much of the dose has been applied, and shows the total dose. The grid circuit of a valve comprises a small condenser which is joined to an auto-transformer. The secondary of the transformer is connected through a telephone with the anode battery and the anode, and in another branch with the filament. The ionisation chamber or high resistance to be tested shunts the condenser. The grid being charged negative, the telephone keeps quiet until the condenser discharges; then a crack is heard, and this repeats. The number of cracks is proportional to the resistance value. In the actual instrument the telephone is replaced by a relay which works the escapement of a clockwork. Fluctuations in the filament and anode batteries, if not exceeding 15 %, do not matter. H. B.

802. *Medical Applications of Diathermy.* **P. Duhem.** (Soc. Franç. Élect., Bull. 6. pp. 1202–1208, Oct., 1926.)—The application of direct current to the human tissues to produce useful heat effects by the Joule effect is directly impossible, owing to sensation and risk of burning. High-frequency oscillatory current can be so applied and is used in medicine under the title of diathermy. Experiment shows that such heat effects may be produced and demonstrated by thermometers placed in the current paths, which show increased temperatures when compared with temperatures shown by thermometers not in the current path. Physiologically this heat effect causes vaso-dilation and lowering of blood pressure. As a result of the heat effect the respiratory exchange is decreased with beneficial results. The urinary secretion is also affected with an increased diuresis, according to most investigators. Various analgesic and trophic effects are produced in the nervous tissues. The technique of the method is discussed. B. J. L.

803. *Problems of Electropathology.* **F. Schwyzer.** (Schweiz. Elektrot. Verein, Bull. 17. pp. 505–525, Nov., 1926.)—The precautions taken to prevent electrical accidents are becoming more and more effective, partly owing to constant improvements of apparatus and partly to more stringent regulations. Contrary to this progress the medical treatment of electrocuted persons has made little progress. Great difficulties arise, since the compositions of living tissues are extremely complex, although the actual effects of the passage of electrical currents through the body must be ultimately based upon the theory of ionic conduction and atomic properties. The author attempts to place the medical aspects before the technicians, and the electrotechnical aspects before the medical reader. He proposes an hypothesis in which the action of non-continuous currents upon the living cell and the production of lesions are due to ionic oscillation. Further medical research in the domain of electropathology will no doubt yield a better prognosis for the treatment of those suffering from severe electrical shock, the safety measures for the prevention of which are in the meantime being continuously perfected by technical progress. The pathological results of electrical shock and burns and their therapeutic treatment are considered very thoroughly in the paper, which does not, however, permit of brief abstraction. B. J. L.

CHEMICAL PHYSICS AND ELECTROCHEMISTRY.

804. *Heat of Adsorption of a Gas by Solid Bodies.* **B. Ilíin.** (Phys. Zeits. 27. pp. 591–598, Sept. 15, 1926.)—Continuing a previous communication, the author investigates the relationship between adsorption and surface constants, and calculates the surface tension of a solid body in vacuo, and the relationship of the adsorption capacity with the heat of adsorption. The results of the investigation show that the heat of adsorption depends upon the pressure of the surrounding gas in a similar way to the variation of the surface tension of a surface active solution with the concentration. The possibility of applying the laws of gas adsorption to the Gibbs-Langmuir effect is indicated. F. J. B.

805. *True and Apparent Adsorption.* **P. N. Pawlow.** (Kolloid Zeits. 40. pp. 116–120, Oct., 1926.)—The diminution of the solute calculated from the difference between the initial and final concentrations of the solution caused by adsorbents capable of taking up the solvent is termed the apparent adsorption. The quantity of dissolved substance actually taken up from the solution by the swollen adsorbent is named the true adsorption. The relationships between these two and the various forms assumed by the adsorption curves are considered. T. H. P.

806. *Electrochemical Method for Estimating the Corrosion of Iron and Steel.* **H. Beeny.** (Am. Electrochem. Soc., Trans. 48. pp. 103–117; Disc., 117–125, 1925.)—The corrosion of iron and steel was studied by an electrochemical method in a 0·2 % solution of sodium chloride. A gold kathode was used which was immersed to the extent of forty times the area of the anode, thus minimising the kathodic polarisation. The progress of corrosion was observed through a microscope. The quantity of electricity liberated by the corrosive reaction itself was measured electrically and analytically. The agreement between the two values was taken to indicate that the corrosion was entirely electrochemical. Experiments were made to determine the effects of varying the quantities of air or oxygen in solution upon the rate of solution. The results indicated that a purely chemical effect either does not exist, or is slow and unimportant compared with the electrochemical corrosion reaction. Manganese as sulphide was found to stimulate the local corrosion, and manganese carbide and manganese in solid solution had practically no influence on the corrodibility of the metal. F. J. B.

807. *Solubility Relations of Naphthalene.* **H. L. Ward.** (J. Phys. Chem. 30. pp. 1316–1333, Oct., 1926.)—Solubility determinations are made of naphthalene in a number of different solvents by rotating a sealed tube containing definite quantities of solvent and solute in a bath and noting the temperature at which all of the solid phase disappears. The values of log N are plotted against 1/T, where N is the molecular fraction of napthalene dissolved and T the absolute temperature. On the assumption that the latent heat of fusion is independent of the temperature, the modified Raoult expression $\log N = \frac{-L_F}{4\cdot 58}\left(\frac{1}{T} - \frac{1}{T_m}\right)$ shows that log N plotted against 1/T gives a straight line whose origin is determined by the melting point of the naphthalene and whose slope is $\frac{-L_F}{4\cdot 58}$ where L_F is the molal heat of fusion. For the higher naphthalene concentrations the graphs of log N against $1/T$ are relatively straight, but at lower concentrations it is apparent that a factor is strongly operative which causes positive deviations from Raoult's law and solubilities less than the ideal. The amount of such deviations, as would be predicted from Hildebrand's theory, increases with increasing differences in internal pressure, and the relative positions of the curve are as would be expected on the basis of this theory. The curvature in this region is very marked with substances which differ considerably from naphthalene in internal pressure. A further influence is apparently exerted by polarity effects. [See also Abstract 1674 (1923).]

J. N. P.

808. *Liesegang Rings.* **K. Jablczynski.** (Kolloid Zeits. 40. pp. 22–28, Sept., 1926.)—The general theory of the formation of Liesegang rings is discussed, and a method of following their formation is developed. A solution of carefully cleaned gelatine to which potassium dichromate was added was prepared. Two microscopical object glasses were separated by two cover glasses so as to form a space of 0·22 mm. in thickness between the two glass slips. This space was filled with the gelatine solution, the excess cleaned off, and the whole placed in a paraffin wax trough. One cubic centimetre of 0·5 N silver nitrate was dropped into the trough and the rate of movement of the coloured diffusion line was observed. Alternative measurements were made on the rate of formation of rings when the formation took place from the periphery to the centre, and from the centre to the periphery. The results are in good agreement with the theory developed in the paper. F. J. B.

809. *Effect of Hydrogen-Ion Concentration on the Viscosity of Hydrosols of Aluminium, Chromic, and Ferric Oxides.* **J. H. Yoe** and **E. B. Freyer.** (J. Phys. Chem. 30. pp. 1389–1400, Oct., 1926.)—These hydrosols, containing 0·06, 0·03, or 0·015 % of the oxide, exhibit little or no change in viscosity as the hydrogen-ion concentration diminishes until a critical concentration (p_H = about 7) is reached, the viscosity then increasing rapidly to a maximum ($p_H = 7$ to $8\cdot 4$), and afterwards decreasing fairly quickly to an approximately constant value. With more concentrated ferric oxide sols (0·85 and 0·12 % of oxide), addition of dilute ammonia solution causes a slight fall in the viscosity, followed by a rise to a maximum and a subsequent fall to an approximately constant value. The appearance of this minimum viscosity has been observed with other colloidal solutions and is considered to be a general property, although it may not occur with the more dilute solutions. These changes in viscosity are regarded as due, partly at least, to changes in the degree of hydration of the hydrosols. T. H. P.

810. *Solutions of the Electronegative Elements in Liquid Ammonia.* **F. W. Bergstrom.** (Am. Chem. Soc., J. 48. pp. 2319–2327, Sept., 1926.)—Sulphur dissolves readily in liquid ammonia in accordance with the equation $10S + 6NH_3 \rightleftarrows S_4N_4 + 6H_2S$, the hydrogen sulphide then reacts with the ammonia to give sulphide and polysulphide, while the nitrogen sulphide gives a mixture of the two acids $S(NH)_2$ and $S_2(NH)_2$. Selenium has an extremely low solubility. Solutions of cyanides in liquid ammonia

are found to react very readily with sulphur and selenium, much more slowly with tellurium, and not at all with arsenic. The reaction results in the formation of the corresponding thiocyanates. The following new compounds have been prepared: $Al(SCN)_3 . 5NH_3$; $Mg(SCN)_2 . 4NH_3$; $Mg(SeCN)_2 . 4NH_3$; $Zn(SeCN)_2 . 4NH_3$; $Al(SeCN)_3 . 5NH_3$.
J. N. P.

811. *Space Configuration of Colloidal Particles.* **R. Zsigmondy.** (Zeits. phys. Chem. 124. pp. 145–154, Nov. 28, 1926.)—The author's views (Kolloidchemie, 5th edition, Chapters 17 to 21) are upheld against those of Pauli and Valkó [see Abstract 2486 (1926)]. T. H. P.

812. *Free Energy of Hydration of Ions and the Electrostriction of the Solvent.* **T. J. Webb.** (Am. Chem. Soc., J. 48. pp. 2589–2603, Oct., 1926.)—This is a theoretical investigation, in which the free energy of hydration of a chemically unhydrated ion is obtained as a function of its radius by calculating the difference between the energy necessary to charge the ion in a vacuum and that necessary to charge the ion in water and to compress the solvent in the vicinity of the ion; regard is taken of the fact that the dielectric constant of a molecular medium is not constant in the vicinity of an ion. The contraction of the solvent (electrostriction) due to the pressures resulting from the attraction of the solvent dipoles by the ion is calculated, and from this the partial molal volume of an ion at great dilution as a function of its effective radius in solution.

The solution of the two resulting equations, obtainable for an electrolyte the free energy and partial molal volume of which are known gives the radii of the individual ions and hence their free energies of hydration. The free energies of hydration of the most common ions are obtained in this way and the consequent calculations of electron affinities and lattice energies are made. The values obtained for the radii of the ions of the alkali metals and halogens follow the same order as is given by Bragg [Abstract 2226 (1925)] and by Wasastjerna for the radii of ions in crystals, but are approximately 0·47 Å. greater than these. T. H. P.

813. *Soret Effect.* **J. Chipman.** (Am. Chem. Soc., J. 48. pp. 2577–2589, Oct., 1926.)—When a solution is maintained for some time in a temperature gradient, the upper part being warmer than the lower, a difference in concentration is established between the two parts. This effect, known as the Soret effect, has been investigated in aqueous solutions of a number of acids, bases and salts by means of conductivity measurements. The results obtained in very dilute solutions, especially acid solutions, are quite erratic, but with 0·1 N solutions moderately reproducible results are furnished. The effect appears to be independent of the dimensions of the cell used. The Soret coefficient, defined as the fractional change in the concentration per degree difference of temperature, is zero for lithium nitrate or ammonium chloride solution, but of appreciable magnitude for other electrolytes. T. H. P.

814. *Interfacial Forces in Dispersed Systems.* **A. de Waele.** (Am. Chem. Soc., J. 48. pp. 2760–2776, Nov., 1926.)—The paper deals with the behaviour of mixtures of oil and pigments, and the ratio of the volume of oil and pigment necessary to form a paste is taken as a measure of the piling of the particles of the materials. The behaviour of various pigments is discussed, and the theoretical aspects of the subject are treated. The drying of ink in the printing process is explained by the application of the reversible fugitive rigidity of plastic systems on shear. F. J. B.

815. *Freezing Points of Solutions of Strong Electrolytes in Cyclo-Hexanol.* **E. Schreiner** and **O. E. Frivold.** (Zeits. phys. Chem. 124. pp. 1–15, Oct. 28, 1926.)—*Cyclo*-hexanol was chosen as solvent for testing the osmotic theory of Debye and Hückel, because its dielectric constant is small ($D = 15{\cdot}0$ against water 88·2 at their melting points 24° and 0°), according to Richards and Shipley [Abstract 425 (1920)], and its freezing-point constant is large. But it is a weak solvent, especially for salts of high valency, and it is hygroscopic. The salts studied in a Beckmann apparatus are the chloride, bromide and perchlorate of lithium and guanidine nitrate. The theory of Debye-Hückel is confirmed; $(1 - g)$ (g being the osmotic coefficient of Bjerrum) is found to be inversely proportional to D. H. B.

816. *The Relation between the Space Lattice Constant and Density of Iron-Nickel Alloys.* **A. Osawa.** (Tôhoku Univ., Sci. Reports, 15. pp. 387–398, July, 1926. In English.)—About thirty alloys, covering the whole range of composition, were examined by the powder method, twelve Debye-Scherrer X-ray cameras being used simultaneously. After slow cooling from 1150° C. to ordinary temperature it was found that up to 22% of nickel only the body-centred cube exists, with a parameter increasing slightly with nickel content. Between 22 % and 35 % of nickel both body-centred and face-centred lattices exist, whilst above 35 % the face-centred lattice alone is found. After dipping in liquid air the body-centred lattice alone extends to 30 % of nickel, and the mixed lattices are found up to 35 %. These results confirm those obtained by McKeehan [see Abstract 1525 (1923)] and support the views of Honda on the constitutional diagram of the iron-nickel series. After forging to eliminate blowholes followed by annealing at 1150° C., the densities of the alloys were found (*a*) before and (*b*) after dipping in liquid air. These densities were compared with those obtained from the lattice constants, and they enable an estimate to be made of the proportions of material in either lattice form to be found in any given alloy. The results are as follows: Before dipping in liquid air up to 14·5 % of nickel only the body-centred cube (α) is found. The face-centred cube (γ) then appears and reaches 100 % at 35 % of nickel. Up to 35 % of nickel dipping in liquid air increases the quantity of the α-material at the expense of the γ-material, but above this percentage the material is always γ. These results agree in general with those derived from X-ray examination, but they make the heterogeneous range wider. A. A. D.

817. *Relation between Lattice Constants and Densities in Nickel Steels.* **A. Osawa.** (Tôhoku Univ., Sci. Reports, 15. pp. 619–630, Nov., 1926. 135th Report from the Research Inst. for Iron, Steel and other Metals. In English.)—The alloys were made by melting together nickel shot and a 0·8 % carbon steel, so the carbon content is variable. The X-ray analysis was carried out as before [see preceding Abstract]. The heterogeneous range, containing both body-centred and face-centred material, extends from 5 to 22 % of nickel in the case of annealed samples and from 5 to 35 % in the case of samples dipped in liquid air. The density determination can only be reconciled with the lattice measurements on the assumption that some of the carbon is dissolved in the γ-phase. A. A. D.

818. *Equilibrium of the Series Cryolite-Alumina.* **G. A. Roush** and **M. Miyake.** (Am. Electrochem. Soc., Trans. 48. pp. 153–157, 1925.)—The commercial production of aluminium is exclusively by the electrolysis of the fused alumina-cryolite bath. The solubility of alumina in fused cryolite was investigated, and it was found that the solubility of alumina in cryolite in solid solution extended to about 12 %, and that of cryolite in alumina to about 77·5 %. Metallographic methods were employed to confirm the various solubility limits. F. J. B.

819. *Ionisation by the Slow Oxidation of Phosphorus.* **W. Busse.** (Phys. Zeits. 27. pp. 738–741, Nov. 15, 1926. Paper read before the Deut. Naturforscher u. Ärzte, Düsseldorf, 1926.)—When a piece of white phosphorus is situate in a current of air flowing through a brass tube in which the temperature falls rapidly as the distance from the phosphorus increases, the concentration of the ions increases at first slowly and then very quickly with this distance. The existence of a photoelectric effect at the surface of the phosphorus appears to be excluded, and no illumination is detectable along the tube. It is also improbable that any invisible radiation occurs in the tube. The indication is that dissociation takes place, and this is supported by other experiments. Ionisation is to be expected only if phosphorus pentoxide is formed. This takes up water to give meta-, pyro- and ortho-phosphoric acids, the second of these, which is detectable during the oxidation, decomposing under the conditions favourable to the dissociation. T. H. P.

820. *Catalytic Oxidation of Hydrocyanic Acid. Part II.* **H. Sinozaki** and **R. Hara.** (Tôhoku Univ. Technol. Reports, 6. 2. pp. 1–26, 1926. In English.)—The catalytic oxidation of HCN into NO has been effected by the aid of ten different catalysts, four of which were almost as effective as platinum net. The phenomenon of activation was also observed with metal oxides as in the case of platinum net. The curves giving the relation between HCN concentration and yield of NO at 600° C. and 700° C. are very similar in both of the cases of iron oxide mixed with bismuth oxide and platinum net. The relation between yield of NO and time of contact of the reacting gas with the catalyser has been studied. The results are believed to support the view that HCNO is instantaneously produced in the intermediate stage of oxidation of HCN into NO. With some oxide catalysers solid intermediate oxidation products, such as cyamelide $(HCNO)_n$, cyanuric acid $H_3C_3N_3O_3$, ammonium cyanate and urea were obtained under suitable conditions. W. H. Ge.

821. *Chemical Action of Gaseous Ions produced by α-Particles: Saturated Hydrocarbons.* **S. C. Lind** and **D. C. Bardwell.** (Am. Chem. Soc., J. 48. pp. 2335–2351, Sept., 1926.)—Under the action of α-radiation from radon, ethane, propane and butane each condenses with elimination of hydrogen and methane (approximately $5H_2 : 1CH_4$) to give higher gaseous, liquid or solid hydrocarbons of both saturated and unsaturated character. With methane, hydrogen only is eliminated. The higher the initial hydrocarbon, the more readily the liquid or solid phase is attained. The gaseous products of this action consist solely of saturated compounds, either higher or lower than the original one, this indicating immediate condensation of nascent unsaturated hydrocarbons to form liquids. No reason is advanced for the value of the molecular proportions between methane and hydrogen, but it seems probable that two hydrocarbon molecules unite to form a cluster prior to reaction. The complete oxidation of methane or ethane by oxygen takes place in one step, this indicating the following ion-cluster reactions per ion pair :

$$(O_2 \,.\, CH_4 \,.\, O_2)^+ + (O_2^- \,.\, CH_4 \,.\, O_2) = 2\,CO_2 + 4H_2O,$$

$$(O_2 \,.\, O_2 \,.\, C_2H_6 \,.\, O_2 \,.\, O_2) + (O_2^- \,.\, C_2H_6 \,.\, O_2 \,.\, O_2) = 4CO_2 + 6H_2O.$$

The oxidation of propane or butane is not complete in one step, liquid partial oxidation products being formed. Under the influence of the radiation, methane and carbon dioxide unite to form a caramel or wax-like solid. T. H. P.

822. *Photo- and Radio-Chemical Interaction of Hydrogen and Chlorine.* **F. Porter, D. C. Bardwell** and **S. C. Lind.** (Am. Chem. Soc., J. 48. pp. 2603–2618, Oct., 1926.)—The rates of synthesis of hydrogen chloride by light and by α-radiation have been determined by means of a modified Bunsen and Roscoe actinometer in which the hydrogen-chlorine mixture is circulated by an all-glass magnetic pump through three chambers (1) for light reaction, (2) for X-ray reaction and (3) for absorption of hydrogen chloride in water. In one and the same mixture the number of hydrogen chloride molecules formed at 25° C. per ion pair (M_{HCl}/N) exceeds the number per quantum (M_{HCl}/q) by nearly fourfold, instead of being nearly 250-fold smaller. The ratio of N to q at 25° C. remains constant for all sensitivities through a 500-fold range. By considering total ions of both signs instead of ion pairs, the difference between ion and quantum efficiency at 25° C. is reduced to twofold and at 100° C. it disappears entirely, one quantum absorbed and one ion producing equal reaction for the same sensitivity of gases. This result furnishes fresh support for the Einstein photochemical equivalence law. At least two inhibitors seem to be present, these being oxygen and possibly chlorine monoxide formed by the action of chlorine on water. T. H. P.

823. *Apparently Unimolecular Reaction; Homogeneous Decomposition of Gaseous Propaldehyde.* **C. N. Hinshelwood** and **H. W. Thompson.** (Roy. Soc., Proc. 113. pp. 221–229, Nov. 1, 1926.)—The thermal decompositions of acetone and acetaldehyde [see Abstracts 2226 and 2227 (1926)] are homogeneous reactions occurring with measurable velocity at 400–600° C., the former being unimolecular and the latter bimolecular. With gaseous propaldehyde at 450–600° C., carbon monoxide is removed from the molecule in the almost theoretical amount, and the residual fragments give rise to a mixture consisting principally of methane and ethane, probably together with quite small proportions of more highly condensed products. The decomposition is a homogeneous reaction which is very nearly unimolecular at pressures above 100 mm., but at low pressures the velocity constants fall appreciably. The heat of activation is 55,000 cals. The number of molecules reacting is considerably greater than that given by the expression (number of collisions) $\times\, e^{-E/RT}$, but the discrepancy is less than with acetone. T. H. P.

824. *Theory of Unimolecular Reactions.* **C. N. Hinshelwood.** (Roy. Soc., Proc. 113. pp. 230–233, Nov. 1, 1926.)—It is usually supposed that the energy of activation is confined to a few degrees of freedom, so that the chance that a molecule possesses energy in excess of E is $e^{-E/RT}$ with moderate exactness. The rate of bimolecular reactions is quite adequately expressed by the equation: number of molecules reacting $= Ze^{-E/RT}$, where Z is the number entering into collision. If molecules are activated by collision in unimolecular reactions and the mechanism proposed by Lindemann [Abstract 110 (1923)] operates, the energy E ought in unit time to be communicated to a number of molecules not merely equal to but much greater than the number reacting. The difficulty thus raised would be removed and the number of collisions rendered sufficient for unimolecular reactions if the total energy E could be made up by any distribution among a considerable number of degrees of freedom. Calculation on these lines shows that for the thermal decomposition of propaldehyde, about 12 to 14 degrees of freedom would allow the possibility of activation by collision and a reaction which could be unimolecular by Lindemann's mechanism down to fairly low pressures. In the decomposition of acetone, and, still more, of nitrogen pentoxide, still more degrees of freedom would be needed. Thus this mechanism could not work except with molecules of complex internal constitution, and this is actually the case with the only unimolecular changes known; bimolecular reactions, for which the activation theory holds quite adequately, usually involve simpler molecules. T. H. P.

825. *Results of Recent Photochemical Research.* **B. K. Mukherji** and **N. R. Dhar.** (Zeits. Elektrochem. 32. pp. 501–511, Oct., 1926.)—A discussion of recent work, under the headings: After-effect in photochemical reactions; induction period in photochemical reactions; influence of temperature on photochemical yields; activation of molecules in photochemical reactions; chemical changes not retarded by light; new explanation for abnormally high photochemical yields; intensity of light and velocity of photochemical reactions; increase and decrease of photochemical sensitiveness; order of photochemical reactions; temperature coefficient. The difference between induction period and after-effect is emphasised. The former is met with in many thermal and photochemical reactions. Autocatalytic reactions probably exhibit an induction period on account of the gradual accumulation of accelerators produced by the reaction. With certain photochemical reactions occurring in different regions of the visible spectrum, the yield per quantum in every region increases with the rise of temperature. Contrary to Trautz's statement, oxidations of cuprous chloride in ammoniacal or acid solution, and of pyrogallol, benzaldehyde and sodium sulphide are accelerated in sunlight. T. H. P.

826. *Light Copper-Zinc Accumulators.* **B. L. Rosing** and **(Miss) J. P. Dmitrienko.** (U.S.S.R. Sci. Techn. Dept. Moscow, No. 147. p. 11, 1926. In German.)—The employment of galvanic cells of the Daniell type as accumulators of small capacity (up to 0·1 Ah) is proposed. The cells are specially arranged in closed tubes. It is explained that the given construction provides light cells which can be regenerated by current and show no local reactions. They are specially suitable for high-tension batteries. The weight of a battery of 200 volts is 1500 grammes. J. J. S.

827. *Oxidation Potentials in Liquid Ammonia Involving Quaternary Ammonium Radicals and Alkali Metals.* **G. S. Forbes** and **C. E. Norton.** (Am. Chem. Soc., J. 48. pp. 2278–2285, Sept., 1926.)—A method involving the use of a specially designed cell is devised for the measurement of oxidation potentials of ten quaternary ammonium radicals in equilibrium with their ions and electrons on Pt against Ag electrodes in saturated $AgNO_3$ solution, all in liquid NH_3 at its triple point. Comparisons with alkali metals are also made. The concentrations of free radicals are determined in terms of Ag, after reaction with AgI. The concentrations of the corresponding halides in saturated solution at $-78°$ are also determined. The observed oxidation potentials of the radicals, also of Li, Na and K, all lie within 25 millivolts of one another, thus upholding the analogy between the fifth valence of N and that of an alkali metal. A. B. C. L.

828. *Free Energy and Heat of Transfer of Barium in its Liquid Amalgams.* **P. A. Anderson.** (Am. Chem. Soc., J. 48. pp. 2285–2295, Sept., 1926.)—Suitable experimental conditions for the exact study of liquid Ba amalgam concentration cells are determined. By the use of a solution of $BaCl_2$ in anhydrous N_3H as electrolyte an accuracy of within 0·01 millivolt is obtained in the measurement of potentials. Several cells are studied at 25° C., a few also at 15° C. and at 35° C., at three Ba concentrations. The observed potentials are notably higher than the values calculated from the concentration law. The data are extrapolated to infinite dilution, and the activities and free energies of transfer of Ba are computed. The heats of transfer of Ba are also calculated. The temperature coefficient of the e.m.f. is apparently a function of the temperature, and d^2E/dT^2 positive. The data are applied to test the Cady equation, the measurements indicating that the part of the observed potential due to the chemical reaction is greater than the value given by the heat of transfer term of the Cady equation. A. B. C. L.

829. *Activity Coefficient of Soap Solutions.* **M. Randall, J. W. McBain** and **A. McL. White.** (Am. Chem. Soc., J. 48. pp. 2517–2522, Oct., 1926.)—The activity coefficient is calculated for various soaps considered as typical electrolytes in dilute aqueous solution, the values obtained offering strong support for the ionic micellar theory. B. W. C.

830. *Free Energy of Formation of Zinc Oxide.* **C. G. Maier, G. S. Parkes** and **C. T. Anderson.** (Am. Chem. Soc., J. 48. pp. 2564–2576, Oct., 1926.)—Determinations of the heat of formation, free energy of formation and entropy of ZnO are made by four independent experimental methods. The most satisfactory results are obtained from the measurement of equilibria at high temperatures and extrapolation. Measurements dependent on the e.m.f. of reversible cells appear to furnish the most accurate determination of free energy, but the method involves difficulties in the determination of heats of formation in the case of ZnO. Calculations from low temperature specific heat data and the third law of thermodynamics are satisfactory for practical purposes except for a lack of data at sufficiently low temperatures for a complete test. Values obtained from solubility values and standard electrode potentials are only moderately concordant when good solubility data are available. No evidence of allotropic modification of Zn or ZnO, with energy amounts greater than 300 calories, or of the existence of solutions of ZnO in Zn or *vice versa* is found. A. B. C. L.

831. *Use of Glass Electrodes.* **(Miss) Phyllis M. T. Kerridge.** (Journ. Sci. Instruments, 3. pp. 404–409, Sept., 1926.)—By means of glass electrodes or glass " cells " the p_H of small quantities of liquids, whether coloured, or easily reducible, or turbid, and even of semi-solids such as minced tissues may be rapidly and accurately measured. The technical difficulties may be overcome by suitable simplification of the procedure, and details are here given of the setting-up of the glass electrodes and of the methods of using them in conjunction with either (1) a Dolazalek or Crompton electrometer or (2) a Lindemann electrometer. T. H. P.

832. *Simple Comparison Electrodes for Electrometric Determinations with Permanganate.* **R. Lang.** (Zeits. Elektrochem. 32. pp. 454–460, Sept., 1926.)—By the use of spirals of platinum wire immersed in the solutions, electrometric measurements are made during the titration of arsenious, ferrous and vanadyl salts with a permanganate solution when different comparison electrodes are employed. The examples selected give low, medium and high positive potentials respectively. The procedure is simplified, and a directly connected millivoltmeter may be employed if the comparison electrode is selected so that the potential approaches zero when the end point is reached. The two electrodes of each cell are contained in breakers in which the electrolytes are connected by a tube filled with saturated potassium nitrate solution. During titration the solution is stirred mechanically. Using 0·1N . $KMnO_4$ for the titration of solutions containing hydrochloric acid, a suitable comparison electrode is given by 0·03 c.c. of 0·1N . $KMnO_4$ in 50 c.c. of 3N . HCl, and in the titration of solutions containing sulphuric acid by 0·01N . $KMnO_4$ a suitable comparison electrode is formed by 0·03 c.c. of 0·01N . $KMnO_4$ in 50 c.c. of 2N . H_2SO4 + 1–2 gm. NaCl. The presence of HCl has a lowering and levelling action on the permanganate potential. The best conditions for the titration are given by an alkaline medium as yielded by an alkali carbonate in order to maintain a constant concentration of hydroxyl ions which affects the potential of the different valency stages of the manganese. It is preferable to add excess of permanganate and titrate back with arsenite when the reduction of the permanganate proceeds directly to MnO_2 without production of manganate and until the whole of the permanganate is reduced does not go beyond MnO_2. The most satisfactory comparison electrode is given by a solution of 1 drop of 0·1N . K_3FeCy_6 and 1 drop of 0·01N . K_4FeCy_6 in 50 c.c. of N alkali carbonate, the use of permanganate being unsuitable in the alkali medium. J. N. P.

833. *Potentiometric Determination of Hydrogen-Ion Concentrations at Higher Temperatures.* **I. M. Kolthoff and F. Tekelenburg.** (K. Akad. Amsterdam, Proc. 29. 6. pp. 766–775, 1926.)—Hydrogen-ion concentrations at temperatures up to 70° C. were determined by potentiometric measurements. At the higher temperatures the calomel normal electrode was found to be unreliable, and a quinhydron electrode in a liquid containing 0·01N hydrochloric acid and 0·09N potassium chloride was used as a comparison electrode. In principle the hydrogen electrode

V.3
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is preferred for the higher temperatures to both of the preceding electrodes. The temperature coefficient of the N-calomel electrode was found to be + 0·00059, of the quinhydron electrode in the acid mixture − 0·00031, of the hydrogen electrode in the same acid mixture + 0·00046. From the last value the temperature coefficient of the normal hydrogen electrode was calculated to be + 0·00087. The combination quinhydron electrode-hydrogen electrode was found to have a temperature coefficient of − 0·00076. F. J. B.

834. *Adsorption of Ions by Metallic Mercury.* **J. E. Rosenberg** and **G. Stegeman.** (J. Phys. Chem. 30. pp. 1306–1315, Oct., 1926.)—A measurement is made of the potential between a stream of mercury flowing at a regulated rate from a funnel immersed in an electrolyte and a stationary mercury surface in contact with the same solution. The mercury at the base of the cell containing the dropping electrode is isolated by a layer of carbon tetrachloride under the electrolyte. The potential is found to vary with the velocity of flow and with the length of the stream of mercury in contact with the solution containing mercury ions; the greater the velocity and the shorter the length of stream the more negative is the flowing mercury to the stationary mercury. In an electrolyte of 0·1N . KCl or 0·1N . HCl solution saturated with calomel, the potential approaches the value − 0·53 as a minimum at high velocities. The difference of potential is attributed to the adsorption of mercury ions at the surface of the mercury electrode, while an appreciable time is required for the adsorption to reach the maximum value. The single electrode potential is not directly affected by the concentration in the bulk of the solution, but is determined by the concentration of ions at the electrode surface. It is considered that the absorption of ions by a metallic surface may have some influence in producing overvoltage. J. N. P.

835. *Influence of the Ionic Charge on the Osmotic Behaviour of Alcoholic Solutions.* **O. E. Frivold.** (J. Phys. Chem. 30. pp. 1153–1161, Sept., 1926.)—Ebullioscopic measurements are made with LiCl, $CoCl_2$ and $La(NO_3)_3$, as representing ions of different valency, in methyl and ethyl alcohol. In accordance with the inter-ionic theory of Debye, the results agree closely with the Debye equation

$$\frac{\Delta' - \Delta}{\Delta'} = 1 - g = a\frac{w}{(DT)^{3/2}}\sqrt{\nu\gamma},$$

where Δ' represents the elevation of boiling point required by the classic theory, Δ the measured elevation, g the osmotic coefficient, $a = 9{\cdot}82 . 10^5 . w = \left(\frac{E\nu_i F_i^2}{E\nu_i}\right)^{3/2}$, where ν_i is the number of ions of the type i into which a molecule of the salt is dissociated and F_i is their valency, D is the dielectric constant, T the temperature, $\nu = E\nu_i$, the entire number of ions into which a molecule of the diluted electrolyte is dissociated and γ the concentration expressed in gm.-mol. per litre solution. At higher concentrations when the dimensions of the ions are not small in comparison with the dimensions of the ionic atmosphere, a divergence from the proportionality given is obtained in accordance with the requirements of the theory. From these divergencies a calculation is made of the mean diameter of the ions. J. N. P.

836. *Static Potentials of Copper and Zinc in Cyanide Solutions.* **W. M. Walker, J. H. Sorrels** and **J. M. Breckenridge.** (Am. Electrochem. Soc., Trans. 48. pp. 47–58; Disc., 58–60, 1925.)—The static potentials of copper in solutions of copper cyanide in sodium cyanide and in potassium cyanide, and of zinc in solutions of zinc cyanide in sodium cyanide, were determined. The variation of the potentials with time, ranging from 24 to 41 hours, was followed so as to determine the effects of the air, oxygen, and carbon dioxide on the electrodes. The protective action of a layer of oil on the surface of the electrolytes, and the chemical corrosion which occurred in the absence of a current were also investigated. F. J. B.

837. *Action of Metals on Nitric Acid* **E. J. Joss.** (J. Phys. Chem. 30. pp. 1222–1275, Sept., 1926.)—The literature on this subject is discussed and a theory enunciated according to which the action is considered as a special case of the electrolytic theory of corrosion. The factors determining the nature of the products formed are the specific reducing power of the metal, measurable by the hydrogen overvoltage in a corresponding sulphuric acid solution and the catalytic actions of the metal and of its nitrate on the different reduction products. By means of a voltage cell arrangement the various factors may be isolated and analysed in any particular case, and in this way it is shown that many metals are identical in their chemical and electrochemical reactions when the disturbing factors are removed. Evidence is advanced to show that the real depolariser in the action of metals on nitric acid is nitrosic acid, $H_2N_2O_5$. T. H. P.

838. *The Hydrate Problem. Part IV. Adsorption of Electrolytes by Parchment Paper and Electro-Endosmosis.* **H. Remy** and **H. Reisener.** (Zeits. phys. Chem. 124. pp. 41–48, Oct. 28, 1926.)—Results are given of investigations of the adsorption of hydrochloric acid, potassium chloride, barium chloride and *p*-toluidine hydrochloride from aqueous solutions by parchment paper on the basis of conductivity measurements. Only with hydrochloric acid could adsorption be detected in the concentration region 0·1 to 0·001N. As is shown by potentiometric measurements, barium ions are replaced to some extent and potassium ions to a less degree by hydrogen ions. To the increasing affinity of the ions towards parchment paper in the order, toluidinium, potassium, barium, hydrogen there corresponds, in accord with theory, decreasing specific electro-endosmosis of the 0·001N chloride solutions. In only moderately dilute solutions, however, the amounts of water displaced when an e.m.f. is applied are by no means in agreement with the adsorbabilities. The conclusion that in the region of moderate dilutions the electro-endosmosis becomes unimportant in relation to the electrolytic transference of water [Abstract 902 (1926)] is hence confirmed. T. H. P.

839. *New Method of Measurement in Alternating-Current Electrolysis.* **A. Fürth.** (Zeits. Elektrochem. 32. pp. 467–470; Disc., 470, Oct., 1926. Paper read before the Deut. Bunsen Gesell., Stuttgart, May, 1926.)—A method of measuring the potential of an electrode during electrolysis with alternating current was developed. This involved the instantaneous switching in and out of the circuit of the measuring galvanometer, and the use of a specially designed auxiliary electrode. The apparatus was tested by using silver nitrate solution, and the current-potential curve for the electrolysis was obtained. **Foerster** pointed out in the *Discussion* that the method could be applied to the study of passivity. F. J. B.

840. *Separation of Hafnium and Zirconium by the Ionic Migration Method.* **J. Kendall** and **W. West.** (Am. Chem. Soc., J. 48. pp. 2619–2627, Oct., 1926.)—After prolonged electrolysis of an agar gel containing hafnium and zirconium as complex anions by the method described in an earlier paper [see Abstract 478 (1925)] a slight but distinct concentration of hafnium in the rear of the section occurred, a difference of some 2 % in the average atomic weights of front and rear segments being established. The compound $Na_4Zr(Hf)(C_2O_4)_4$ is employed by dissolving a quantity of ammonium fluozirconate containing about 5 % hafnium in water, precipitating with ammonia and dissolving the hydroxide in the calculated quantity of sodium hydrogen oxalate solution and then adding to a hot agar solution. The front gel consists of sodium sulphate and the rear gel sodium oxalate. The degree of separation is smaller than that previously attained in the application of the method to the rare earth metals. An attempt is made to correlate the similarity of the velocities of zirconium and hafnium ions, contrasted with the considerable differences which apparently exist in the rare-earth group, with prevalent notions of the atomic structures of the elements in question. J. N. P.

841. *Colloidal Dispersion in the Electrolysis of Aqueous Solutions by Direct and Alternating Current.* **Emma Jirsa.** (Kolloid Zeits. 40. pp. 28–33, Sept., 1926.)—The formation of dispersed colloidal sols at the kathode and anode during electrolysis with direct and alternating current is discussed. These sols are probably oxides when they are formed at the anode, or by alternating current. In the case of gold and platinum the quantity of metal disintegrated is greater with alternating than with direct current. Gold forms a sol of metal, the intermediate formation of Au_2O acting as a depolariser. Under similar conditions platinum is disintegrated. Lead sols were also obtained. F. J. B.

842. *Disintegration of Carbon Anodes in Aqueous Solutions of Nitric Acid.* **H. J. M. Creighton** and **W. H. Ogden.** (Am. Electrochem. Soc., Trans. 48. pp. 21–25; Disc., 26–29, 1925.)—Electrolysis of strong aqueous solutions of nitric acid between carbon electrodes results in explosive disintegration of the anode, probably as a result of pressure developed in the internal pores of the electrode by the combined action of the acid and electrolytic oxygen on the carbon. Possibly graphitic acid is formed in the earlier stages of the electrolysis and explodes later with formation of carbon monoxide and dioxide and water. The authors' conclusions are criticised in the discussion. T. H. P.

843. *Effects of Nitrates on Current Efficiency of Plating Solutions.* **P. A. Nichol** and **O. P. Watts.** (Am. Electrochem. Soc., Trans. 48. pp. 31–33; Disc., 33–35, 1925.)—Addition of 40 grammes of sodium nitrate per litre to a nickel sulphate plating bath prevents deposition of the metal. Lead and copper nitrate baths give kathode efficiencies of 97 and 99 % respectively, but other nitrates tried yield unsatisfactory results. Addition of sodium nitrate to silver cyanide baths causes appreciable diminution in current efficiency. Continued use of baths containing nitrates may result in the formation of nitrites and other injurious products with deleterious effects. T. H. P.

844. *Plating of Chromium on Steel.* **G. M. Enos.** (Am. Electrochem. Soc., Trans. 48. pp. 37–44; Disc., 44–46, 1925.)—Chromium is plated on steel containing 0·18 % carbon from a solution containing 3 grammes of chromium sulphate, 245 grammes of chromic acid, and 5 c.c. of concentrated sulphuric acid per litre of water. The current density employed is 37·7 amps. per square decimetre (350 A/sq. ft.). The steel specimens are hung from a busbar in the middle of the battery jar with two anodes of cast chromium on each side. The temperature is not allowed to exceed 24° C. The weight of chromium deposited over the average area of 22·8 sq. cm. of each test piece varies, for a plating time of one hour, from 0·2 to 0·3 grammes. Attempts are made to combine a process of plating, heat treating, and case hardening. It is concluded that at ordinary case-hardening temperatures, chromium as plated does not absorb carbon, *i.e.*, is not cemented to any appreciable extent. No procedure could be found which would give surfaces which are hard and at the same time resistant to corrosive media. Chromium plate on steel prevents cementation for the ordinary time and temperature conditions employed in case hardening. J. N. P.

845. *Electrodeposition of Copper-Nickel Alloys.* **H. D. Hineline** and **W. B. Cooley.** (Am. Electrochem. Soc., Trans. 48. pp. 61–66; Disc., 66–68, 1925.)—The simultaneous deposition of copper and nickel from solutions of a mixture of the double cyanides was studied. The solutions contained from 50 to 150 grammes per litre. Coatings of a wide range of composition were deposited, the presence of 5 to 40 grammes of potassium chloride per litre improved the corrosion of the anode. The deposition was best carried out at a temperature of not higher than 18° C., and the very high current density of 25 amps. per square decimetre was employed. The composition of the deposited mixture of metals was controlled by the current density, or by a change in the composition of the bath. The deposit of mixed metals was found to be extremely ductile, suggesting an unusual state in the metal. F. J. B.

846. *Protective Value of Nickel Plating.* **C. T. Thomas** and **W. Blum.** (Am. Electrochem. Soc., Trans. 48. pp. 69–87; Disc., 87–102, 1925.)—Experiment shows that present methods fail to yield quite impervious deposits of nickel on steel, deposits as thick as 0·05 mm. exhibiting distinct porosity. The only practicable means of enhancing the protective value of the nickel plating is to increase the average thickness of the deposit to at least 0·025 mm., a relatively thick copper deposit either under or between the nickel deposits being of advantage. The surface of the steel should be thoroughly cleaned, best by methods involving mechanical scouring and the production of a passive surface upon the steel by anode cleaning or pickling. The increase in the rate of deposition necessary to the economic production of thick deposits may be attained by a high concentration of the nickel salt and ions, increased concentration of the hydrogen ions, moderate mechanical stirring (moving kathodes), freedom of the liquid from suspended matter, relatively high temperature, and anodes of pure nickel. T. H. P.